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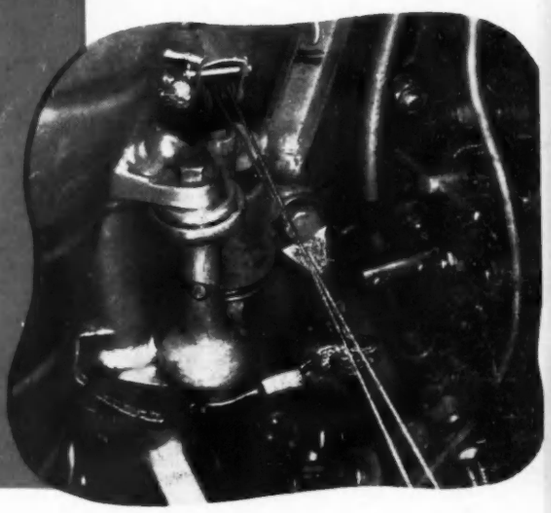
AUTOMOTIVE and Aviation INDUSTRIES

DECEMBER 15, 1942

Horsepower literally floats on Timken Bearings

Dynafocal Suspension Service Reaffirms Timken Bearing Leadership In The Air . . . .



Timken Tapered Roller Bearings have given highly successful service in Dynafocal suspension assemblies.

The bearings are used in links spaced symmetrically around the engine mounting ring and connected to the rear of the engine. Each link has two pivot points; one a tube and the other is formed by two Timken Bearings pressed into the link forging. Through controlled directional spring restraint, this flexible mounting arrangement results in a true center of gravity support for the assembly, the isolation of vibration and yet contains sufficient stability for landing and erratic flying.

Timken Bearings permit the links to float freely. They must carry radial loads set up by the thrust of the propeller plus weight of the engine and thrust loads resulting from propeller torque. Here is still another instance of the "know how" possessed by The Timken Roller Bearing Company in applying bearings in unusual applications, particularly aircraft.

★

As aircraft speeds and loads increase the advantages of Timken Bearings become more pronounced. In new designs study bearing applications with this thought in mind.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

Manufacturers of Timken Tapered Roller Bearings for automobiles, motor trucks, railroad cars and locomotives and all kinds of industrial machinery; Timken Alloy Steels and Carbon and Alloy Seamless Tubing; and Timken Rock Bits.

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TAPERED ROLLER BEARINGS

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The fact that the aircraft industry has chosen Heald Bore-Matics and Grinding Machines for precision finishing such a wide variety of aircraft components speaks for itself. And it's a mighty good reason that you, too, when you specify precision, specify HEALD.

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- Lower Half Crankcases
- Crankcase Sections
- Crankcase Center Sections
- Crankcase Front Sections
- Rear Crankcase
- Crankcase Covers
- Intermediate Crankcase
- Wheelcases
- Volute Casings
- Gear Cases
- Reduction Gear Cases
- Reduction Drive Supports
- Front Covers
- Oil Pumps
- Bearing Supports
- Rear Cam Supports
- Master Rods
- Articulating Rods
- Pistons
- Piston Pins
- Crankshafts
- Crankshaft Rear Sections
- Crankshaft Center Assemblies
- Crankshaft Dynamic Balancer Weights
- Gears
- Impeller Shaft Gears
- Oil Pump Bodies
- Oil Pump Covers
- Fuel Pump Bodies
- Oil Pump Scavenger Casings
- Water Pump Casings
- Master Rod Bearings
- Crankshaft Bearings
- Bushings
- Master Rod Spacer Bearings
- Valve Inserts
- Valve Tappets
- Valve Tappet Guides
- Valve Spring Lock Washers
- Valve Spring Washers
- Carburetor Bodies
- Spark Plug Parts
- Magneto Housings
- Magneto Breaker Adapters
- Magneto Plate
- Magneto Gear Housing
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- Distributor Blocks
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- Generator End Shields
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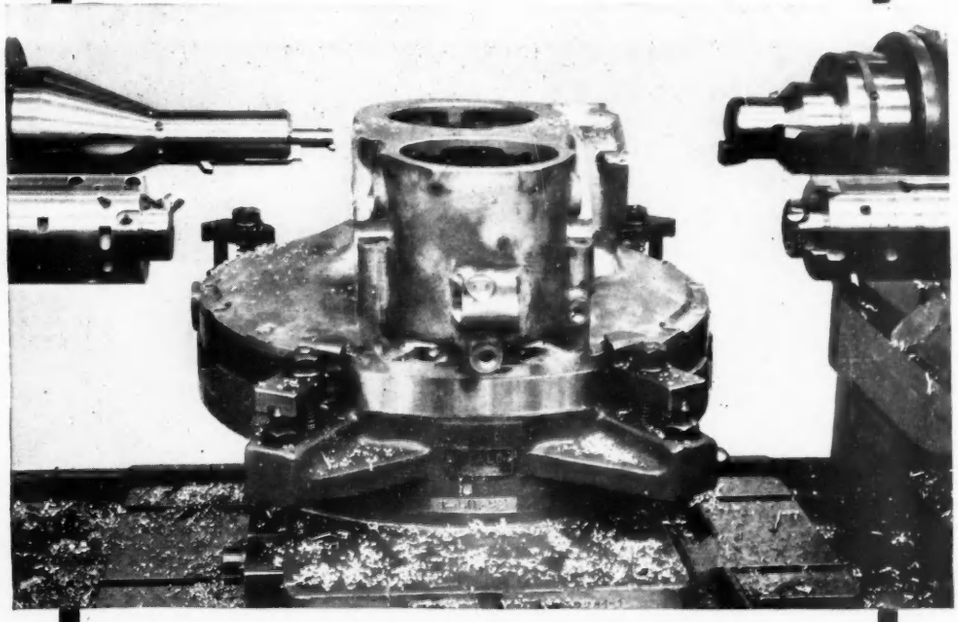
- Camshaft Brackets
- Clutch Selector Housings
- Crank Pin Oil Plug
- Crankshaft Oil Plug
- Fuel Pump Drive Shaft
- Fuel Pump Drive Shaft Support
- Gear Housings
- Knuckle Pin Locking Plate
- Push Rod Ball Ends
- Regulator Housings
- Roller Cams
- Valve Housings
- Valve Brackets
- Valve Bushings
- Control Motor End Shields
- Selsyn Motor Stators
- Hydraulic Operating Cylinders
- Gun Synchronizer Bearing Liners
- Tail Gear Treadle Assemblies
- Propeller Blades
- Propeller Blade Bushings
- Propeller Shafts
- Propeller Hubs
- Propeller Shaft Bearings
- Propeller Spiders
- Propeller Cams
- Propeller Hub Cones



ABOVE — Here a Heald No. 49 Double End Bore-Matic bores, faces and chamfers 21 surfaces in crank case rear covers made of magnesium alloy, all in one work setting.

★ ★ ★ ★ ★ ★ ★

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AUTOMOTIVE and Aviation INDUSTRIES

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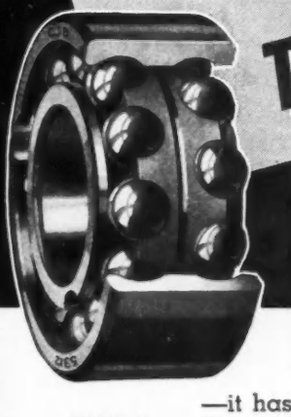

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IN THIS ISSUE . . .

AUTOMOTIVE
and AVIATION
INDUSTRIES

Volume 87 December 15, 1942 Number 12

AUTOMOTIVE INDUSTRIES
Reg. U. S. Pat. Off.

Impact Extrusion of Airplane Parts

For many years collapsible tubes and containers for semi-liquid materials such as tooth paste, shaving creams and paints have been made of tin, lead and other soft metals by what has become known as the impact-extrusion method. As compared with other possible methods of production, the impact-extrusion method is simpler, faster and far less expensive. In the impact-extrusion process a single press stroke forms a slug or blank of metal into the completed article, the high-pressure developed causing the cold metal to flow in the dies as required.

Many airplane parts normally produced by casting or machining from solid stock could be produced much more rapidly and economically by the impact extrusion process, and the possibilities in this field were discussed recently by Phil Koenig, master mechanic of Consolidated Aircraft Corp. Aluminum and its alloys can be extruded by the impact method, and it has been found that pure aluminum requires a pressure of about 45 tons per sq in. for extrusion, and the 24S alloy, approximately 90 tons. The process is of particular interest to the aircraft engineer because it can be used for many parts now produced in drop hammers, and increasing difficulty is experienced in obtaining drop forgings.

Air vs. Rail and Water Transport in the Postwar Period 17

There are big happenings in the aircraft field. Greater than is generally known. Engineers are doing many things in their designs that are accomplishing the "impossible." What effect they are going to have on the transportation scheme in the days to come is the theme of this article. Things will be different. Read how.

Propellers in the Making 20

This is a behind the scenes story of just how the Nash-Kelvinator plant is turning out automatic variable pitch propellers. It is liberally illustrated to show the technique of a really big job well done.

Power Recovery in Testing Aircraft Engines 26

There are three fundamental types of test equipment for testing aircraft engines, the propeller house, the absorption dynamometer and the feedback system. The last is the only one that offers any return for the fuel spent in the tests. In these days of conservation it is well to be informed. This article describes the equipment and procedure in the Buick plant at Melrose, Ill.

Formability of Aluminum Alloys 32

The application of aluminum to aircraft fabrication is a subject vital to the war program and its development will find many places in the industry after the war. This technical treatise on the subject is of unusual interest at this time.

DC Generators for Aircraft 36

With the introduction of bigger and yet bigger planes for the fighting forces problems have appeared that were not in the picture a few months ago. Not the least of these is the ever increasing load that has been placed on the electrical generators. This article tells in a concise way just what is happening in this field. Read it.

A Tough Spot for a Spring, too!

UNCLE SAM'S anti-aircraft guns make the skies a tough spot for enemy planes, but these fast-firing guns are also tough on their own component parts.

The recoil springs, for example, must absorb the terrific kick of powerful shells many times per minute —function flawlessly, despite the intense heat generated by such rapid and continuous action—and combat that arch enemy, corrosion, at all times. But Muehlhausen Springs are doing this remarkable job—for they are designed, fabricated and tested to meet the most rigid requirements; have that extra strength and stamina to take a real beating under all conditions.

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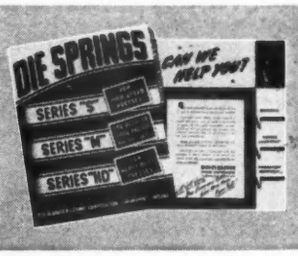
- New Die Spring Bulletin illustrates, describes 206 sizes and types of die springs.
- New Armament Bulletin shows importance of springs for many types of war equipment.



AUTOMOTIVE and AVIATION INDUSTRIES

Published on the 1st and 15th of the month

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December 15, 1942

Air vs. Rail and Water

Transport in the

Postwar World

By W. A. Patterson
President of United Air Lines

TODAY there is considerable discussion of the postwar future of the airplane, and public opinion seems to range all the way from the feeling that the airplane is "here to stay" to the unbridled feeling that the airplane will drive other forms of transportation out of business. As one who has been active in aviation for fifteen years, I have great confidence in the postwar of aviation. I firmly believe in the peacetime to come that the airplane will occupy an important place in the international scheme of transport and communications of our new world. On the other hand, I feel that this picture is being distorted perhaps in a harmful way by overenthusiastic predictions of the influence of the airplane in the postwar world.

The vital part air transportation is playing in this war will not be fully known until some day in the future, because of the confidential nature of many of its present activities. We can say, however, that the flexibility of the airplane is proving of immeasurable value. The territory served by air transportation companies of this country is far greater than the average person realizes.

When statements are made that our older forms of transportation, the railroads and steamship lines, are doomed, such statements cannot be supported by facts. Air transportation will augment surface transportation, not supplant it. Surface transportation

This article is an abstract of a paper presented by Mr. Patterson November 24 at the National Industrial Conference in New York City.

Vital military supplies are loaded aboard this former United Air Lines Mainliner. War plants also depend upon air express, regular nightly schedules being maintained between contractors and sub-contractors and also overnight service between New York and Pacific Coast cities.

Interior of a former luxury airliner that has been converted into an Army cargo carrier.

will progress as a result of air transport's development, rather than be retarded by it. When we evaluate the use of the airplane in our present war activity we must realize that cost is an unimportant factor in our wartime transport formula. In peacetime commerce, we do know that the dollar cost of transportation becomes all important in determining the transport method which will be used.

Let us examine the relative cost of freight transportation by surface means and by air. These comparative costs which I will give you are the result of much research and study by our Statistical and Economic Research Department to find some of the answers ourselves. They are, of course, based on the operating costs of present airline equipment, such as is now in commercial operation in this country. First let us compare the freight train with the cargo airplane on the basis of normal peacetime conditions.

The average freight train would consist of 50 cars, 30 of them loaded with 26 tons of freight each, and 20 of them empty. Such a freight train, based on actual railroad statistics for the year 1940, would carry a total of 780 tons. Operated between Chicago and San Francisco, it would give sixth morning delivery and could make two round trips in a month's time.

Therefore, every month it would deliver a total of 1560 tons each way between those two points. An oil burning locomotive pulling this train would consume 170,000 gallons of fuel oil during the month, which at 2 cents a gallon would cost $3400. The operating crew on such a freight train would number five men, and an equivalent of four crews or 20 men would be required to keep the train running. Their total pay would be approximately $5,000 for the month. The total operating cost of the train, based on 1940 railroad experience, would amount to $50,000 for the month, which represents the cost of moving 1560 tons by rail from Chicago to San Francisco, and another 1560 tons from San Francisco to Chicago during the interval of one month, or two round trips.

Now, let us do the same job by airplane, using the familiar Mainliner type of equipment which is now in use on our line, but converting it to small cargo-type airplanes. The average lifting capacity of such an airplane would permit it to nibble in small bites of only 2¼ tons each at the 1560-ton pile of cargo moved by the freight train in one month's time. It would take 626 bites, or 626 airplane round trips between Chicago and San Francisco to do the same job that the freight train did in two round trips. This represents 2,500,000 miles of flying compared to 8880 freight train miles.

A single airplane could not make that many round trips between Chicago and San Francisco in a month's time. Normal operating experience would indicate 11 round trips per month per airplane as the average. On this basis 57 airplanes would be required to do the job of the freight train. During the month these airplanes would consume 1,500,000 gallons of gasoline, compared to the 170,000 gallons of fuel used by the train. The gasoline would cost a total of $200,000 compared to a cost of $3400 for the fuel used by the train. 400 pilots would be needed to fly the airplanes as against 20 crew members to keep the train running. The pilots would receive a total of $200,000 in pay for the month while the payroll for the train crew members would amount to $5000. Based on recorded experience, the total operating costs of the airplanes would amount to $1,750,000 during the month while the freight train costs would total $50,000. The airplane operation would therefore cost 35 times as much as the freight train.

What has the airplane contributed to the economic picture in return for this large additional expenditure? Speed? In both examples the same number of tons have been moved the same distance in the same length of time—the ton-miles-per hour are the same. Of course, two freight trains could move the the entire 1650 tons from Chicago to San Francisco in six days time and our airplanes could do it in about half a day, if 626 of them were assigned to the job—but that is another story. Prior to December 7, there were only 362 commercial transport airplanes in use on all the airlines in the United States.

For the large bulk of commodities, speed in transit is a relatively unimportant consideration. The most important factor is the rate of flow—the laying down at destination of a given number of tons per month.

In the example I have just given, one Mainliner type cargo airplane was approximately equivalent to one freight car in the amount of work accomplished per month. If the airplane is to be visualized as taking over the entire job of all the freight cars in the country this is perhaps an unfair comparison. Due to the long-haul nature of our example, we made the

freight car work overtime, 300 miles a day, as against an actual country-wide annual average of only 36 miles a day. If the airplane were to take over the entire job being done by the nation's freight trains, its efficiency might be expected to drop too, because of the short-haul characteristics of the preponderance of traffic, the unbalance between directional movement, seasonal fluctuations, and the tremendous terminal problems that would result.

A fair comparison might be to expect one of our present-day airplanes to do the work of three freight cars. It is reported that we have in this country 1,800,000 freight cars and on this basis 600,000 transport airplanes of the present commercial type would be required to replace them. During a year's time these planes would consume 122 billion gallons of gasoline, which is two and one-half times more gasoline than the pre-war cracking equipment capacity of all the refineries in the world. 2,500,000 pilots would be needed to fly this fleet, and the total airline personnel would run 20,000,000, or 15 per cent of our entire population. This would be a very substantial contribution to the solution of any postwar unemployment problem, if only the cost were not so great.

Let us now turn to a comparison of today's ocean-going freighter and the cargo airplane. For our freighter we will use a vessel of 13,000 tons loaded displacement similar to the type currently being constructed in great numbers by our shipyards for the Maritime Commission, and we will sail it between San Francisco and Brisbane, Australia. The revenue load of such a ship would be 6400 short tons, and in peacetime operation it might be expected to make the round trip of 14,000 statute miles in two months' time. The fuel oil consumed for the round trip voyage would be 425,000 gallons which would cost $9000. There would be 55 in the crew and their pay for the two months' period would total $15,000. Based on the experience of a coastwise shipping company, probably high for trans-Pacific operation, the total operating costs chargeable against the two-month round trip would be $120,000.

The airplane we are going to use to perform this same job of moving 6400 tons of freight from San Francisco to Brisbane and another 6400 tons on the return trip, all in two months time, would be of the four-engined type which but for the war might be in use on our airlines today, and which is currently being used by the Army in some of its transport operations. Such an airplane would carry four tons of revenue load over the distance required between fuel stops, and therefore 1440 trans-Pacific round trip flights would be required over a period of two months to transport the load carried by the surface freighter in one round trip. This requires an airplane departure every hour, and represents 21,000,000 miles of airplane flying compared to 14,000 miles of surface ship travel.

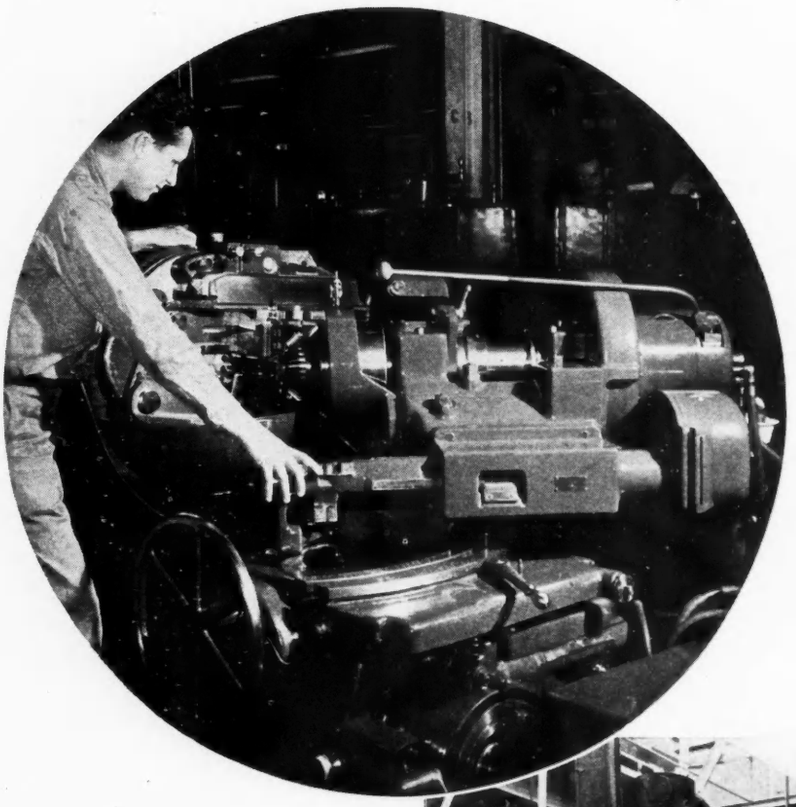
An airplane can make the round trip in six days and therefore could fly ten round trips in two months. 144 airplanes would be required. These airplanes would consume about 18,000,000 gallons of gasoline while the boat was burning less than a half million gallons of fuel oil. The cost of this gasoline would be $2,250,000 compared to $9,000 for the ship's fuel. Thirty-five hundred airplane crew personnel would be needed as against 55 to man the boat. The airplane crews would receive a total of $3,000,000 in pay for the two months compared to $15,000 in wages paid to the ship's crew. Total airplane operating costs, based on present figures, would reach an aggregate of $29,000,000—250 times the surface freighter's round trip cost of $120,000. Again, both have performed the same job in ton-miles-per-hour.

Refueling is still another problem that the airplane would have to meet in competing directly for the more substantial tonnage capable of being carried by the ocean vessel. Nearly 15,000,000 gallons of gasoline would have to be transported to intermediate points and to Australia every two months by ocean-going tankers. Three such tankers would be required for this purpose so that actually 144 airplanes plus three tankers would be required to do the job that could be accomplished by one ocean-going freighter in the first place.

These figures which I have quoted are interesting, but their main significance is not appreciated until we trace this transportation cost to the value of some typical commodities that you and I find it necessary to buy. For example, our total exports to Australia the most important single group in

(*Turn to page* 66, *please*)

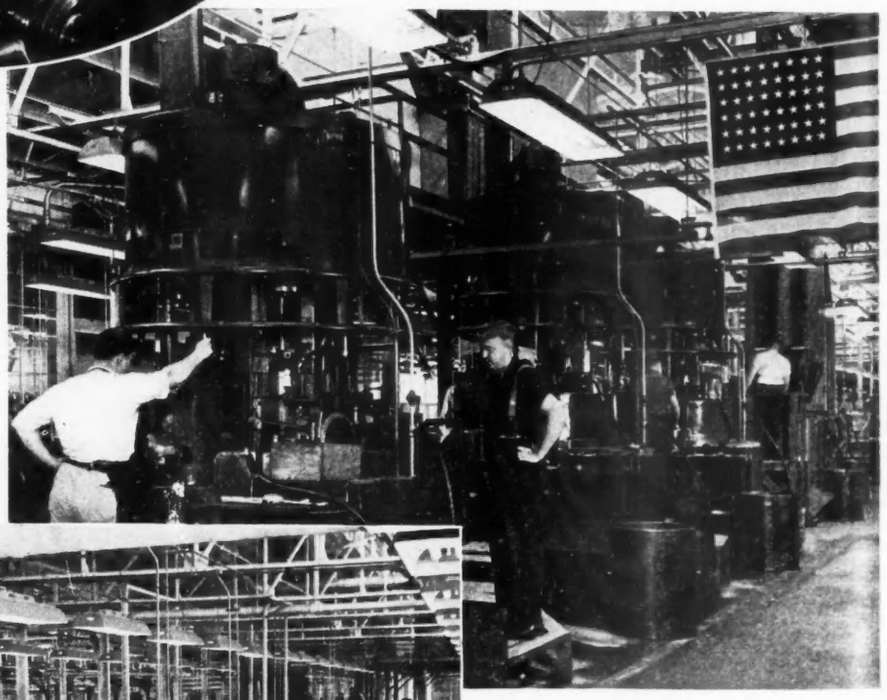
This new canvas slip-cover container for any cargo carried in transport plane cabins has been devised by United Air Lines. As shown here, the containers permit compact shipments and protect the interior finishings of the cabin.

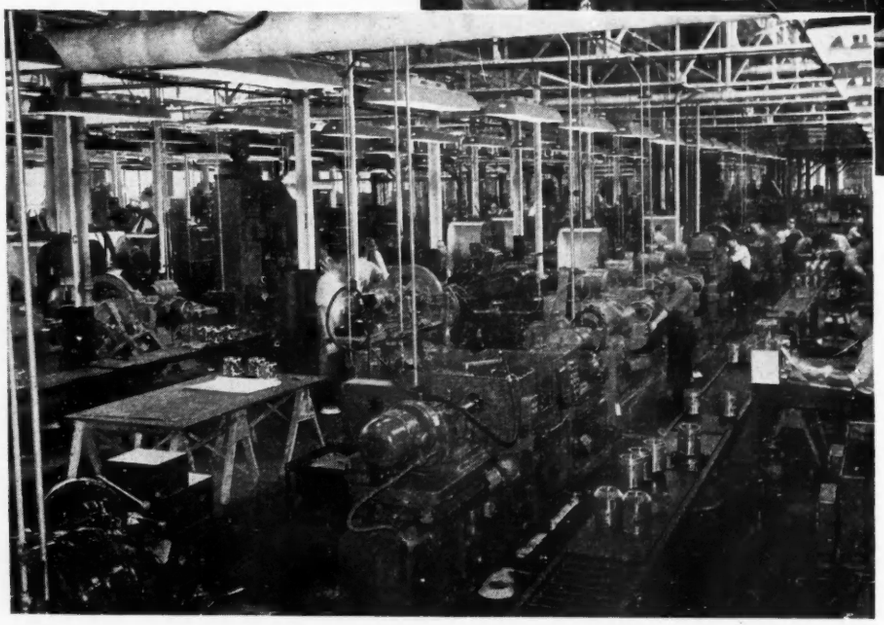


HYDROMATIC propellers — automatic variable-pitch propellers with hydraulic actuating mechanism—for the flying men of America. Here is a behind-the-scenes story of how they are made in one of the finest self-contained operations in the automotive industry. It will always be to the credit of the Nash-Kelvinator Corp., one of the most respected names in the automotive industry, that the initiative and production-wise experience of its organization have combined to contribute importantly to the war program. At this writing the company has made a remarkable record in the production of variable-pitch propel-

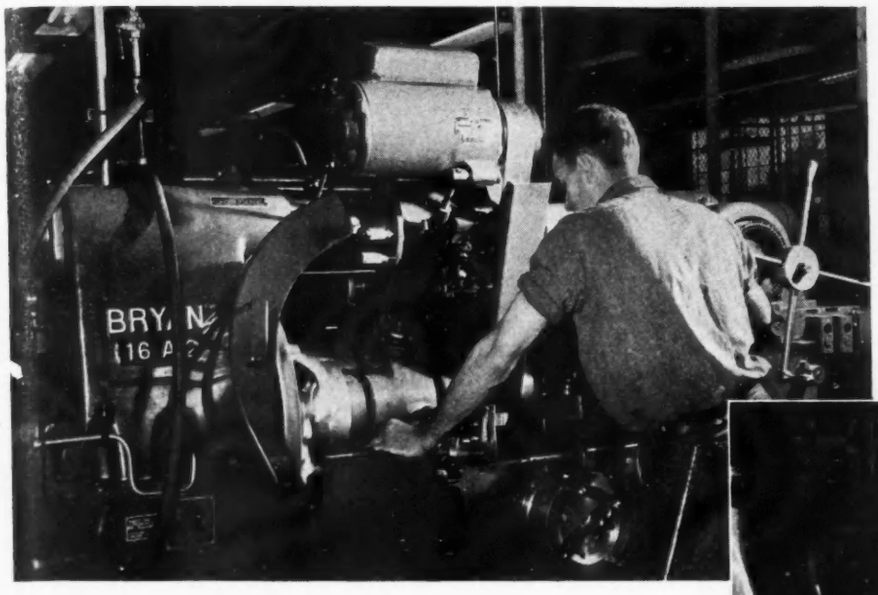
(Circle) One of the new Gleason generators in the N - K gear department.

(Right) Here is one of the batteries of Bullard Mult-Au-Matics in the Nash-Kelvinator propeller plant, marking the initial machining stages of one of the major parts.





(Left) Looking down one of the machine shop bays—stationary and rotary cam department, with Natco horizontal drilling machine in foreground. Note the gravity roller conveyors; and the closely-spaced fluorescent light fixtures overhead.



(Left) One of a battery of new Bryant internal grinders used on many internal bores, including finish-boring of the barrel halves.

(Below) One of the many inspection benches in the blade department. Note the massive surface plate; and the sine-bar template gage for checking each section of a blade.

Propellers in the Making

at the Nash-Kelvinator Plant

By Joseph Geschelin

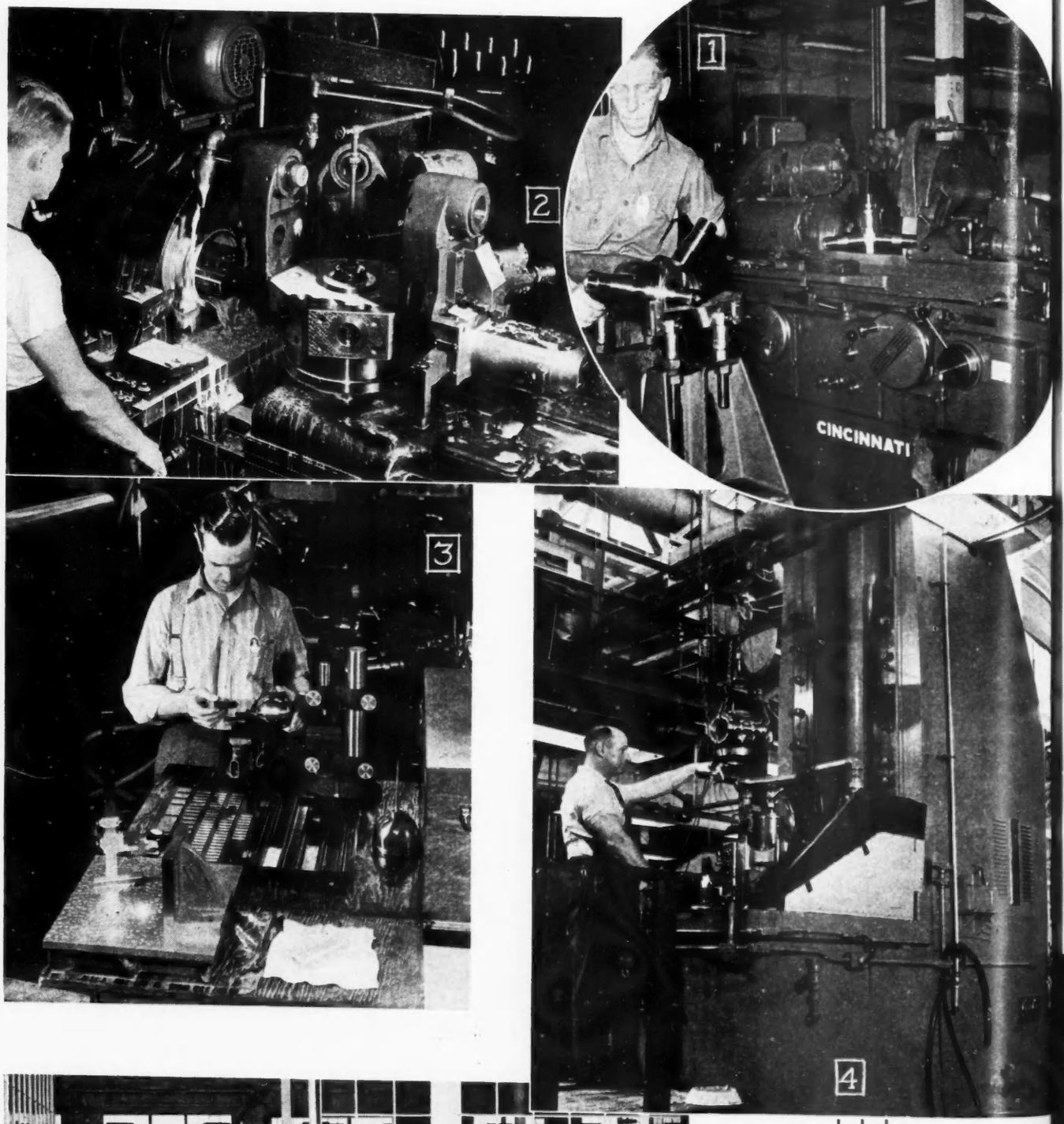
lers, and is aiding materially in "keeping 'em flying."

N-K's Propeller Division is housed in several of the old mill type buildings that constituted the ancestral home of Reo motor cars. In this respect the operation is quite unique. Instead of taking time to build a new factory, N-K took over these old structures, rehabilitated them completely, installed new heating units and modern fluorescent lighting throughout, provided new ceilings and partitions, and with a generous use of good white paint, has produced a remarkably new appearing factory. In doing this, it not only saved precious time but made these facilities available without drawing upon critical building materials.

The propeller operation is laid out in accordance with modern planning methods current in our industry. Flow of materials is arranged in conformity with straight line mass production methods, raw materials coming in at one end through the Bond Room proceeding down each of the machine lines, ending up at the other side of the plant in final inspection, and final assembly. Materials handling plays an important role in this process, utilizing modern industrial trucks for all manner of trucking and tiering operations, with monorail conveyors and gravity roller conveyors for the transportation of parts through the machine lines, with hoists to facilitate handling at the machines.

Receiving inspection and the bond room are key elements in quality control. All incoming raw materials and fabricated parts run the gauntlet of receiving inspection. This department is provided with machinery and inspection devices essential to the proper examination and approval of all incoming materials. The bond room, in turn, serves as the clearing house and storage for all fabricated parts that have been approved for installation in propeller assemblies by civilian and AAF inspectors.

Following the practice for which the AAF is noted in assuring the safety of the flying services, quality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control is the basic feature of this operation. Surface finish and dimensional accuracy are held to exceptionally high standards to assure safety and to promote complete interchangeability both here and in the field. How well this has been done may be appreciated by noting a classic experiment. Some short time ago, the Army Air Forces directed that two Hamilton propeller assemblies and two N-K propellers be taken from production and torn down. The component parts then were thoroughly intermingled. Out of the stock-pile, they assembled four propellers. The parts fitted beautifully, indicating perfection of dimensional control, and assuring ready servicing of propellers anywhere in the world where these American-built propellers may be used.

A few examples of dimensional tolerances may be noted here. For instance, on the barrel the center of locating block seats and axis of center bore must intersect within .005, and faces of blade sockets must be perpendicular to plane determined by centers of locating block seat radii within .0012 total indicator reading on 3 inch radius through 360 deg. of rotation. On the spider, the bearing surfaces of the three arms are held to plus 0.0000, minus 0.0005 in. on the diameters for the finish-grind. These arms, spaced 120 deg., are held to angularity and plane alignment within 0.002 in. in 12 inches. Basic diameters of spline sections are held to plus .000 in., minus .005 in. on the diameter.

Precision is maintained by rigid control of all gaging and inspection devices. An interesting development along this line is the use of "gage buggies," portable gaging laboratories containing master gages and a complete assortment of Jo-blocks. These gage buggies, working out of a constant temperature gage control room, are wheeled through the plant by a skilled operator whose responsibility it is to check all shop gages and to assure conformity to standards. In addition, there is a regular inspection of all master gages and blade templates by the master gage laboratories operated by the AAF at Wright Field.

The well-known Sheffield amplifying gages are employed in the inspection department. An outstanding piece of equipment in this connection is a special inspection machine designed for rapid checking of spiders. This is a unique Pratt & Whitney Electrolimit device, fitted with an indicating panel containing eight indicator lights per arm, 24 lights in all.

This plant is particularly fortunate in being able to

1. Cincinnati Filmatic grinder, finish-grinding ends of spider arms to extremely fine tolerance with plunge cut. Note the massive inspection fixture to permit the operator to check his own work.

2. The big aluminum dome for the propeller assembly is turned, faced, and the dome formed on a battery of Potter & Johnston 5D automatic turret lathes.

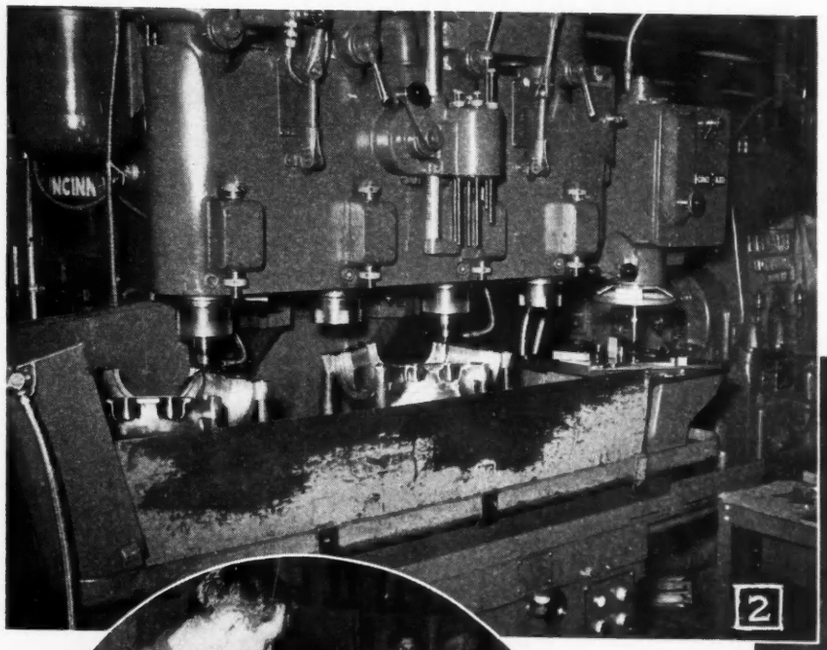
3. Gage Buggy, with its complement of special master gages and Jo-Blocks, wheels down the aisles daily to check on the inspection equipment at each station.

4. Big LaPointe vertical broaching machine, broaching the bore and splining the barrel assembly.

5. View in the shipping department showing one of the Elwell-Parker trucks.

6. Special Sundstrand Rigidmil designed for milling simultaneously the leading and trailing edges of the blade. The cutter heads are actuated by a cam mechanism for generating the contour of the edges.

7. One of a large number of vertical head Heald precision boring machines in the blade department.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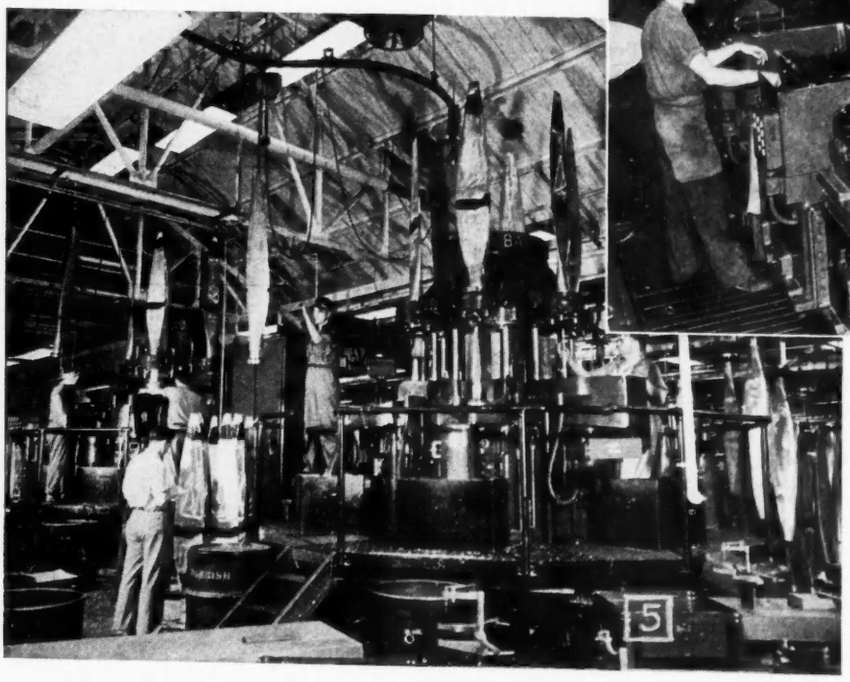
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outfit the machine shops with equipment of the latest types available today. Here will be found many batteries of towering Bullard Mult-Au-Matics, Bryant internal grinders, Norton, Landis, and Cincinnati precision grinders, Cincinnati Hydro-Tels, Gleason generators and gear quenching machines, LaPointe and Cincinnati surface broaching machines, Ex-Cell-O precision thread grinders, Heald precision boring machines and internal grinders, Fellows gear shapers, Natco multiple drilling and boring machines, Sundstrand cam-millers, large batteries of Potter & Johnston turret lathes, Barnes Drill Co. honing machines, Monarch lathes, and many others.

Consider a few of the high-lights of manufacturing operations. Easily the most extensive and impressive department is the one for machining blades. They come in rough aluminum forgings which are inspected for shrinks and cracks, the flash removed with Jarvis flexible shaft polishing machines. Each blade is straightened lengthwise to a template in a 50-ton Oilgear press. Next comes the scribing of center lines for machining operations. First machining operation is on a Hall Planetary machine to rough turn the butt end. Major preparatory operation is the drilling and reaming of the taper hole in the shank on novel inverted vertical Barnes Drill Co., multiple drilling machines. The blade is then twisted to the correct angles of incidence on an Oilgear machine.

The faces of the blade are milled on Sundstrand Rigidmils and Engineering Research Corporation Profilers and the shank finish-turned on a special Heald automatic turning machine. Following inspection operations, the bottom of the blade is faced on a Heald vertical Bore-Matic. Again follows a series of inspection operations to check alignment. Unique is the milling of leading and trailing edges of the blade in a special Sundstrand Rigidmil fitted with a cam attachment for suitably changing the spacing of the two milling cutters.

Then come a series of polishing and inspection operations fitting the blade contour accurately to templates at specified points. It is re-twisted, and straightened, caustic etched, inspected, polished and buffed with Jarvis portable shaft grinders, then balanced and hand-sanded to remove scratches.

All along the line the process is shot through with inspection and balancing operations. Operation 45 is the finish-boring of the taper hole on a Heald precision boring machine, using cemented-tungsten-carbide and

(*Turn to page* 72 *please*)

1. A 50-ton Oilgear press, one of a group used for straightening blades.

2. Close-up of the four-spindle Cincinnati Hydro-Tel used for profiling the seal groove in the faces of the barrel halves. The automatic tracer is at the extreme right.

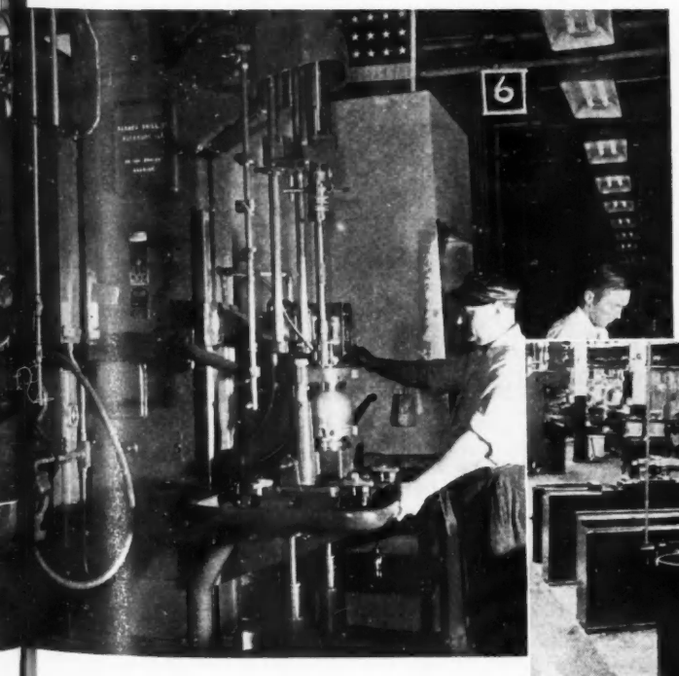
3. One of the benches in the blade polishing department. Jarvis and Kellerflex portable grinding and polishing equipment is employed. Each operator checks his own work with templates to assure accurate conformity to form and dimensions.

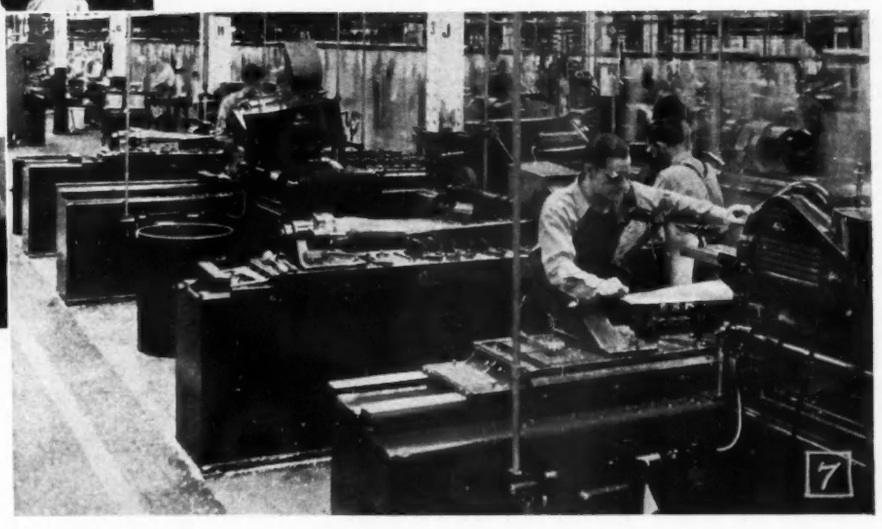
4. Two Fellows gear shapers at the right, foreground, cut 288 serrations on the internal gear section of the stationary cam.

5. Something new! Towering Barnes Drill Co., six-station special machines for core-drilling and reaming the tapered bore in the blade shank.

6. Barnes Drill Co., honing machines fitted with Micromatic hones are employed in the finish-honing of the piston assembly.

7. Engineering & Research Corp., and Sundstrand Rigidmils with special rocking heads adapted for the contouring of the curved surfaces of the blade.





Power Recovery

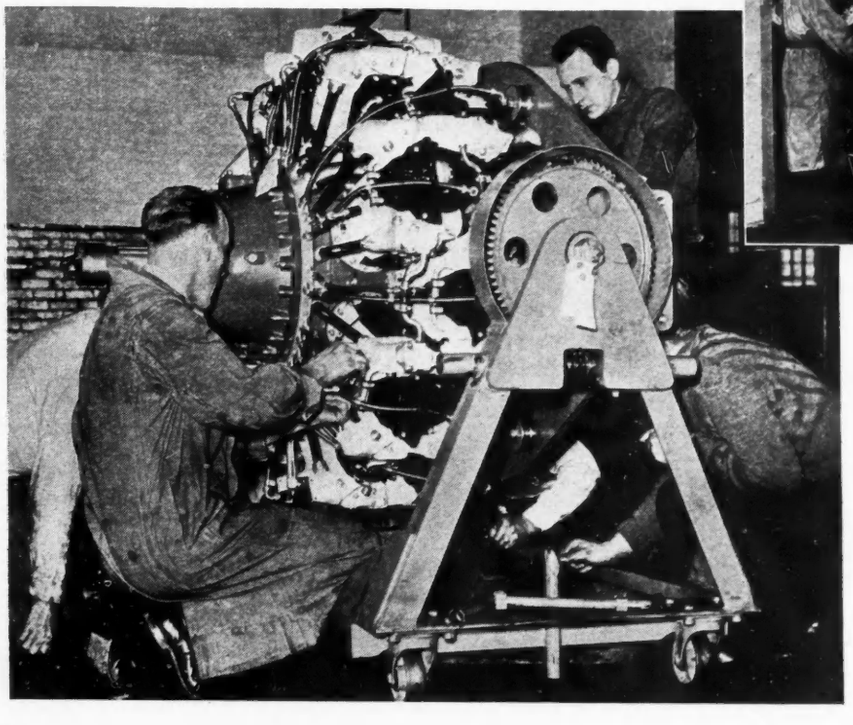
in Testing Aircraft

By C. A. Chayne
Chief Engineer, Buick Motor Division,
General Motors Corp.

WHEN an aircraft engine is delivered to a plane manufacturer it must be ready to "go to work" at once. There is no such thing as flying a plane slowly for so many miles or hours until the engine is "run in." The first thing that a new aircraft engine is required to do is to operate at maximum power in order to get the plane off the ground and into the air. After this has been accomplished the engine may be throttled back to cruising speed and perhaps treated with more than usaul care until the plane has been landed and is ready for another take-off.

Engines not only must be delivered ready-to-run, they also must be thoroughly run-in and ready to go to work. The job that must be done in the test department of an aircraft engine plant is to take the engines as they are delivered from the manufacturing department, run them in thoroughly, and check all phases of their performance.

Three fundamental types of test equipment may be used for this work—the propeller house, the absorption dynamometer, and the feed-back system. The feed-back system is the only one that offers any sort of a return for the money spent for gasoline. Also, its installation involves less expense than properly-designed and equipped propeller houses. Feed-back equipment has been installed in the Buick plant at Melrose, Ill. In the test cells, the engine drive through flexible shaft couplings, magnetic couplings of the eddy-current type. This unit permits the engine

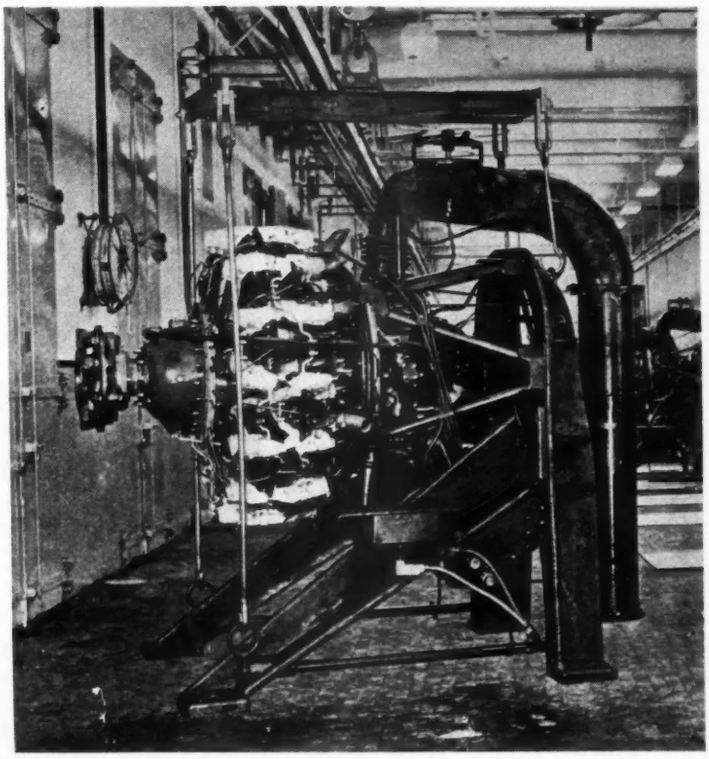


Above
With all electrical and hose connections attached, the shaft coupling and carburetor air piping in place, the engine and mount are moved into the test cell by an overhead monorail crane.

Left
Engines come from the assembly lines mounted on these stands, the wheels of which run in sunken tracks or on rails to keep the stand traveling in line. The worm gear shown serves to rotate the engine on the cradle to any desired angle.

Right
Schematic arrangement of couplings in power-recovery system.

Engines



The engine is mounted on this stand, and flexible connections are attached, ready to be coupled to connections in the test cell.

to be run at whatever speed is desired, maintaining all the while a constant speed on the output shaft of the coupling, which turns an electric generator. Thus, a substantial portion of the power generated by the engines on test is recovered in the form of electric power.

Approximately 63 per cent of the horsepower-hours developed by the engines on test is converted into electric energy and fed back into the power lines supplying the factory. During the months of March, April, May and June, 54.6 per cent of the total electric power used by the factory was supplied in this manner.

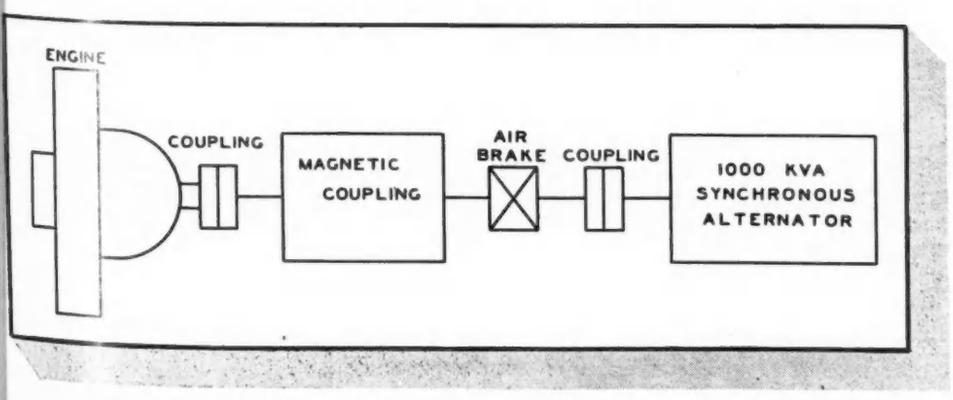
Various automatic safety devices have been included in the equipment to reduce, as far as possible, the importance of the human element in its safe operation. There is, first, an overspeed safety which shuts off the ignition system of the engine should its speed rise above a predetermined figure. Before the coupling can be energized its cooling water supply must be turned on and if the water supply should fail during a test, the coupling excitation goes off and the overspeed safety cuts off the ignition. If the operator should carelessly try to apply the air brake at a time when it should not be applied, the coupling is de-energized and the alternator is tripped off the line and again the overspeed safety shuts off the engine.

Other safety devises either shut off the ignition or flash a warning light or blow a horn if, for instance, the automatic fire extinguisher system in the test cell goes into action or if the exhaust fan which scavenges the cooling air and exhaust gases out of the cells shuts down, or if the oil pressure on the engine drops below a certain value.

Engines to be tested are brought to a preparation room from the assembly department on monorail units. Here they are installed on the stands on which they are supported while under tests. All fittings and connections are installed in this room and, after the engine is completely "dressed up," the engine and stand assembly is then dropped down in place, the shaft coupling bolted up, and the connections to the test stand instrument and to the oil and fuel lines are rapidly made by means of snap-on couplings of various types.

Below the preparation room is a corridor extending the full width of the department which is air-conditioned and in which are located a series of blowers, each of which supplies air through a venturi air flow meter to the carburetor of an engine. This room is kept locked so that unauthorized persons cannot enter it because the air intake of an engine is the most sensitive part of the unit. By conditioning the air in this carburetor air chamber it is possible to reduce the corrections necessary in calculating the engine performance.

The test cells themselves are



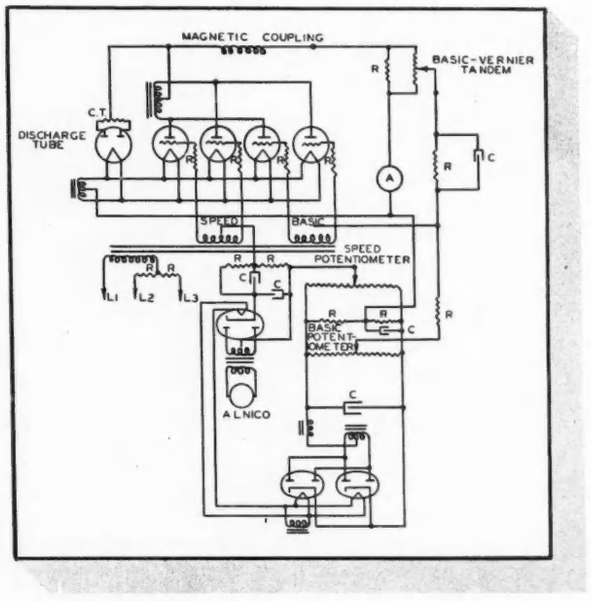


Diagram of electronic control.

square rooms with heavy concrete walls and with double refrigerator-type access doors. A noise seal is used where the coupling shaft projects through the wall of a cell.

Immediately above the cells is a penthouse containing the supply fan for cooling air and an exhaust fan which scavenges the test cell. Inlets and outlets of these fan rooms are equipped with generous sound-proofing.

A common concrete foundation is used for both the engine test stand and the power absorption equipment. This foundation is completely separate from the walls and floors of the main building and because of its large size and the weight of the units installed on it, has very little vibration.

The corridor immediately under the test cells contain the multitude of pipes necessary for supplying oil and water and for connecting the main instruments and gauges in the control rooms to the engines on test. A tunnel carries the electrical connections from the alternators to the master substation.

One characteristic of this building is that all power absorption equipment is in a large well-lighted and well-ventilated room, instead of each individual unit being in a small room, which would make it difficult to get at when servicing operations are required.

Some details of the electrical installations which serves to start the engine and make possible the feed back of electrical energy into power circuits of the plant may be of interest to the technical reader.

A 1000 kva synchronous alternator is connected to the engine under test through a magnetic coupling, which latter prevents shocks to the engine under all operating conditions. After the alternator has been used as a synchronous motor to start the engine, it is

(*Turn to page* 84, *please*)

View of the control room and of some of the instruments used to measure engine performance. A complete log is kept of each test.

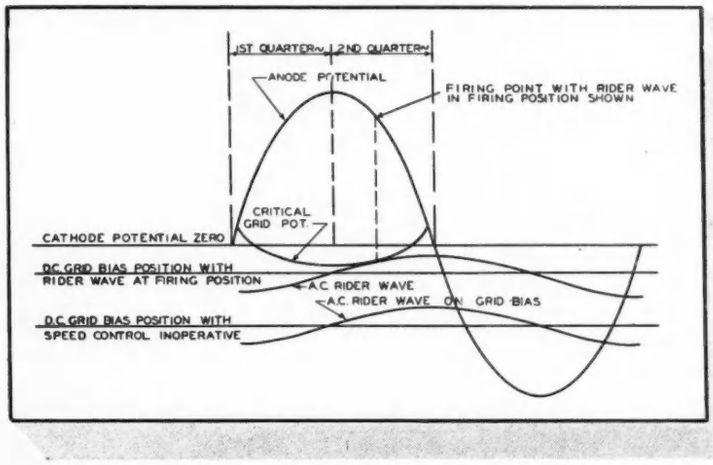
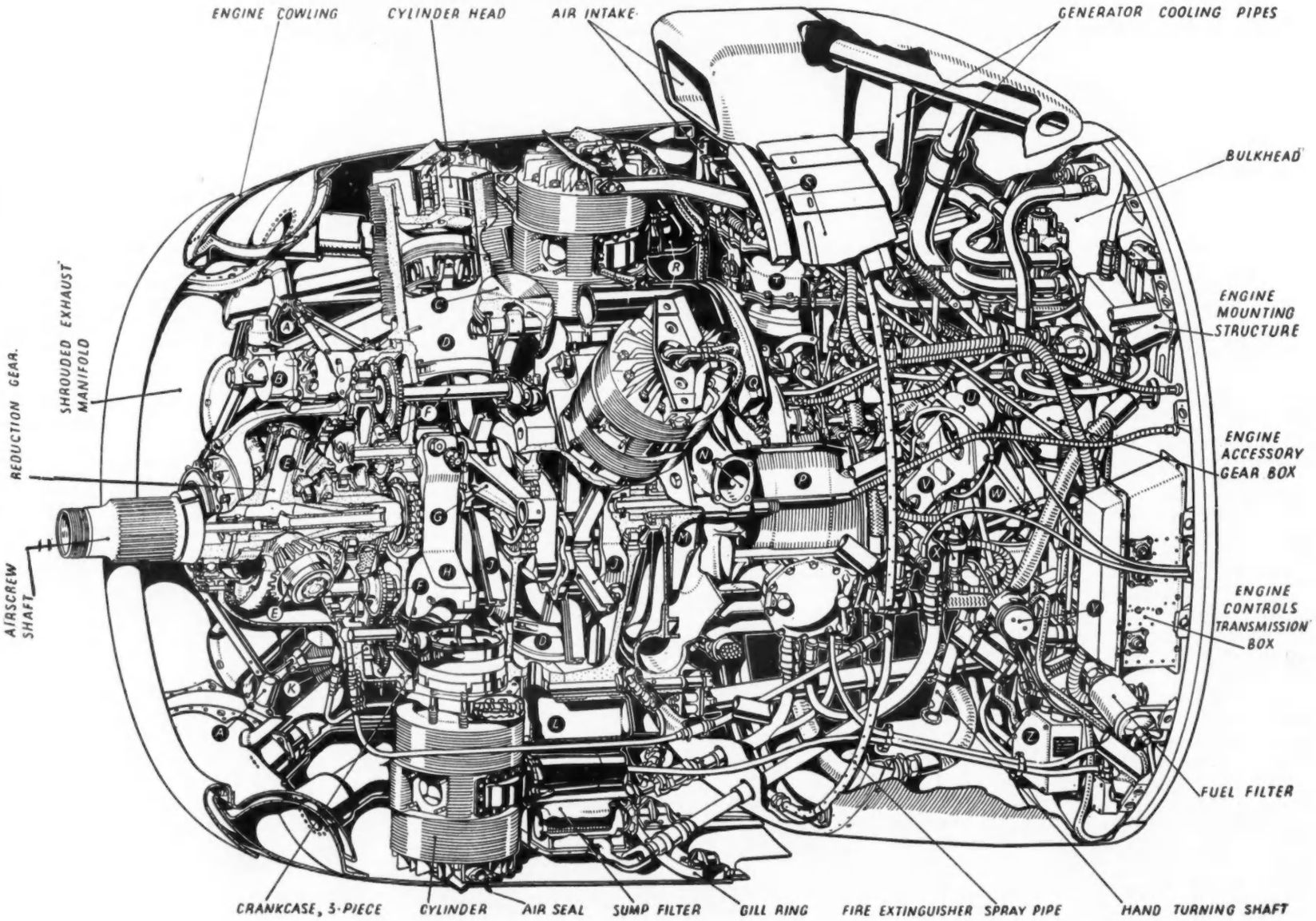

1ST QUARTER
2ND QUARTER
ANODE POTENTIAL
FIRING POINT WITH RIDER WAVE IN FIRING POSITION SHOWN
CRITICAL GRID POT.
CATHODE POTENTIAL ZERO
D.C. GRID BIAS POSITION WITH RIDER WAVE AT FIRING POSITION
A.C. RIDER WAVE
A.C. RIDER WAVE ON GRID BIAS
D.C. GRID BIAS POSITION WITH SPEED CONTROL INOPERATIVE

Diagram showing tube firing point with grid-bias rider wave.

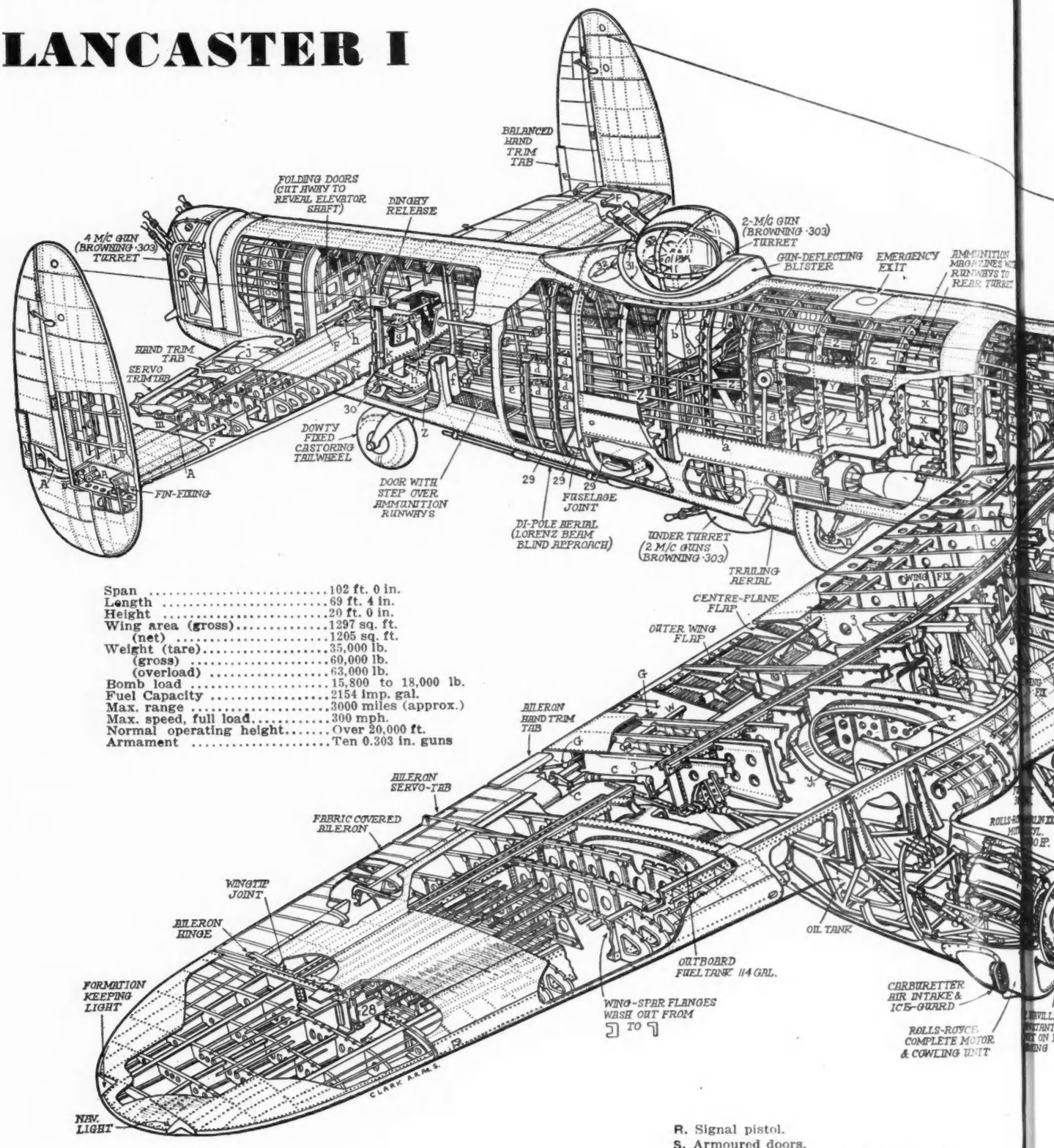
The grid-bias position is moved up or down in the negative-potential region by means of the speed-control potentiometer setting, and carries the a-c rider wave with it. The Alnico speed-governor generator moves this grid-bias potential up or down instantly and automatically. Any point of either quarter cycle where the d-c grid bias or the a-c rider cuts the critical grid curve determines where the tube begins to fire. Being gas-filled, the tube then fires till the end of the half-cycle.

Bristol Hercules 1600 Hp 14-Cyl Power Plant



A Exhaust Manifold Tripod
B Airscrew Governor Unit
C Piston Assembly
D Cylinder Sleeve
E Reduction Gear Bevel Pinions
F Sleeve Drive Mechanism
G Master Connecting Rod
H Crankshaft
J Articulated Rod
K Front Cover Scavenge Pump
L Oil Sump
M Supercharger Impellor
N Supercharger Outlet
P Two Speed Supercharger Unit
Q Engine Mounting Ring
R Induction Pipes
S Controllable Gills and Support Ring
T Carburetor
U Magneto (Port)
V Oil Dilution Valve
W Electric Starter
X Oil Pump Unit
Y R.P.M. Indicator Generator
Z Main Electrical Junction Box

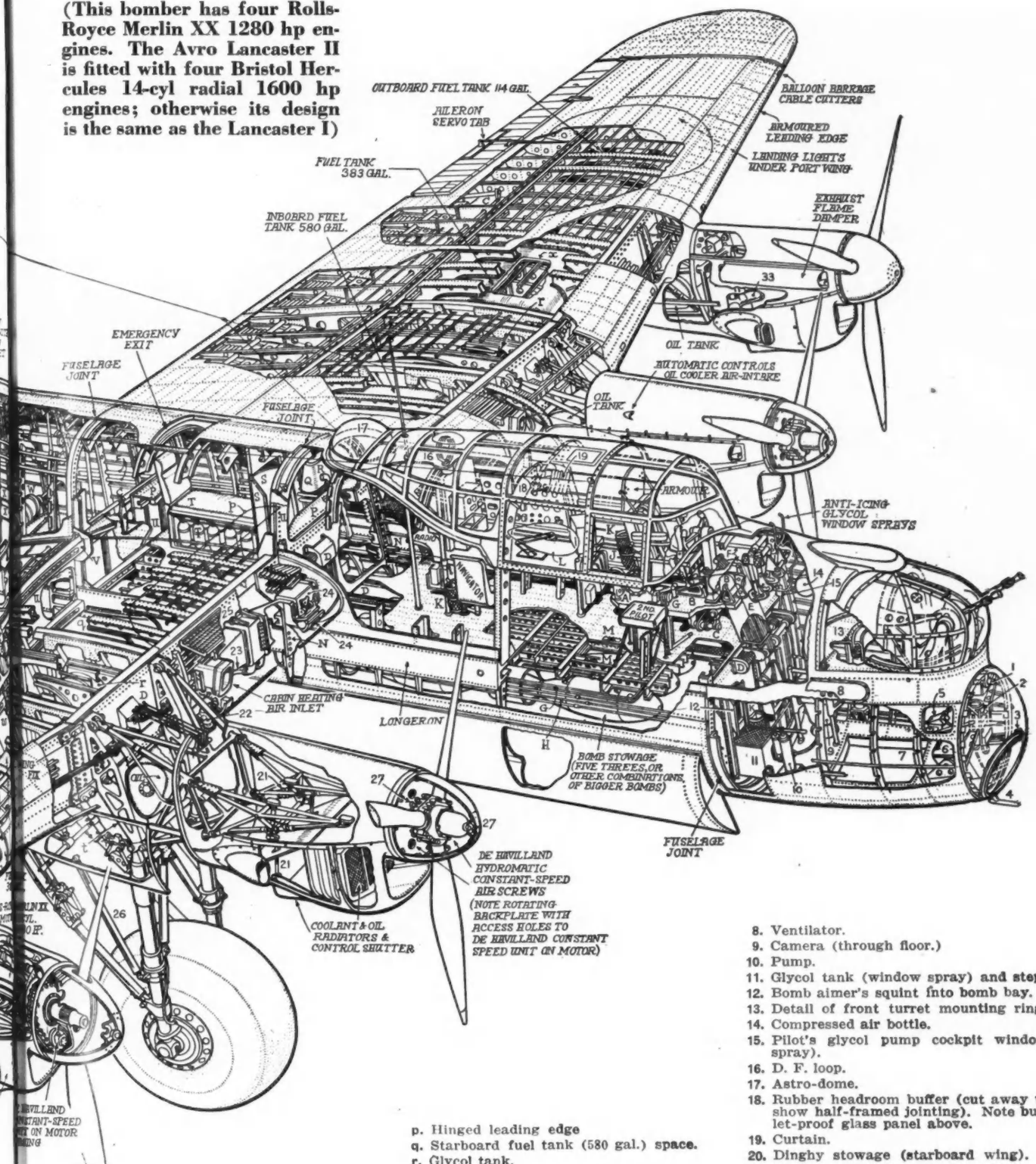
BRITAIN'S AVRO-LANCASTER I



Span	102 ft. 0 in.
Length	69 ft. 4 in.
Height	20 ft. 0 in.
Wing area (gross)	1297 sq. ft.
(net)	1205 sq. ft.
Weight (tare)	35,000 lb.
(gross)	60,000 lb.
(overload)	63,000 lb.
Bomb load	15,800 to 18,000 lb.
Fuel Capacity	2154 Imp. gal.
Max. range	3000 miles (approx.)
Max. speed, full load	300 mph.
Normal operating height	Over 20,000 ft.
Armament	Ten 0.303 in. guns

A. Rudder and elevator trim.
B. Control column stops and seat raising cam.
C. Aileron control.
D. Throttle controls.
E. Rudder bars.
F. Rudder and elevator control rods.
G. Aileron trim cables to screw rod.
H. Service piping along bomb bay.
J. Parachute stowage (end of Nav. Table).
K. Oxygen bottle stowages.
L. Observer's window blister.
M. Bomb lock units in floor.
N. Longeron joint flanges and holes.
P. Spar flange reinforcement.
Q. Hydraulic reservoir.
R. Signal pistol.
S. Armoured doors.
T. Rest bunk and 15 oxygen bottles underneath.
U. Spar webs extended into former frames.
V. Spar flanges.
W. Flap op. cylinder and op. rods
X. Reconnaissance flares.
Y. Flare chute shown stowed and in position.
Z. Tail gun ammunition magazine and runways.
a. Under-turret magazines.

(This bomber has four Rolls-Royce Merlin XX 1280 hp engines. The Avro Lancaster II is fitted with four Bristol Hercules 14-cyl radial 1600 hp engines; otherwise its design is the same as the Lancaster I)


OUTBOARD FUEL TANK 114 GAL.
AILERON SERVO TAB
FUEL TANK 383 GAL.
INBOARD FUEL TANK 580 GAL.
BALLOON BARRAGE CABLE CUTTERS
ARMOURED LEADING EDGE
LANDING LIGHTS UNDER PORT WING
EXHAUST FLAME DAMPER
EMERGENCY EXIT
FUSELAGE JOINT
OIL TANK
AUTOMATIC CONTROLS OIL COOLER AIR-INTAKE
ARMOUR
ANTI-ICING GLYCOL WINDOW SPRAYS
NAVIGATOR
2ND PILOT
CABIN HEATING AIR INLET
LONGERON
BOMB STOWAGE (FIVE THREES, OR OTHER COMBINATIONS OF BIGGER BOMBS)
DE HAVILLAND HYDROMATIC CONSTANT-SPEED AIR SCREWS (NOTE ROTATING BACKPLATE WITH ACCESS HOLES TO DE HAVILLAND CONSTANT SPEED UNIT ON MOTOR)
COOLANT & OIL RADIATORS & CONTROL SHUTTER

b. Top turret magazines.
d. Vacuum flasks stowages.
e. Dead-man's handle (puts rear turret fore and aft to extricate gunner through sliding door).
f. Elsan lavatory.
g. Tailwheel leg spigoted into tailplane
h. Tailplane halves joints.
j. Elevator trim screw rod and cables.
k. Tailplane fix to fuselage.
m. Elevator hinge bracket.
n. Bomb door op., jack and mud brushes (and at front end).
p. Hinged leading edge
q. Starboard fuel tank (580 gal.) space.
r. Glycol tank.
t. Undercarriage and motor bracket.
w. U/c radius rod and jack anchorages.
x. Fuel tank structure (swash-plate former plates, stringers, plating and bullet-proof skinning).
y. Fuel tank support strap.
z. Wing trailing section spar (bolted to wing rear spar).
1. Navigation light.
2. Bomb aiming sight.
3. Flat window (no distortion) and glycol anti-icing spray pipe.
4. Air-speed pressure head.
5. Glycol pump for "3".
6. Bomb aimer's body rest.
7. Emergency exit.
8. Ventilator.
9. Camera (through floor.)
10. Pump.
11. Glycol tank (window spray) and step.
12. Bomb aimer's squint into bomb bay.
13. Detail of front turret mounting ring.
14. Compressed air bottle.
15. Pilot's glycol pump cockpit window spray).
16. D. F. loop.
17. Astro-dome.
18. Rubber headroom buffer (cut away to show half-framed jointing). Note bullet-proof glass panel above.
19. Curtain.
20. Dinghy stowage (starboard wing).
21. Radiator control jack and rods.
22. Fuel cocks (remote controlled).
23. Hot glycol pipes into cabin heater.
24. Worm drive (cabin air heat controls) and air overflow.
25. Service pipes along leading edge.
26. U/c door op. link rod.
27. Spinner and back plate fixing to air-screw hub.
28. Wing-tip joint.
29. Downwards indentification lamps.
30. Tailwheel leg hinge.
31. Taboo track and rollers.
32. Aerial spring suspension.
33. Carburetter air intake junction (up to carburetor).

Formability of A

By Given A. Brewer
Research Engineer,
Lockheed Aircraft Corp.

Fig. 1a—Enlarged view of cross section through typical power brake bends. Material 24ST Alclad.

IN AN article on "Technical Aspects of Sheet Metal Forming" by F. R. Shanley of the Lockheed Aircraft Corp., which appeared in AUTOMOTIVE AND AVIATION INDUSTRIES for Oct. 1 and 15, it was pointed out that sheet metal forming of a permanent nature—that is, where the part retains its shape after the removal of the forming load—can be accomplished only

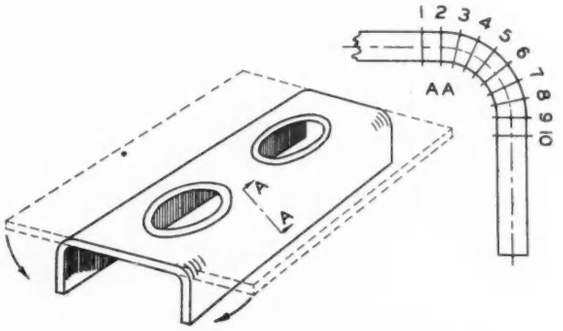


Fig. 1—Simple bending operation.

by plastic deformation. This plastic deformation is the result of shear slippage along intercrystalline planes of the metallic crystals which constitute the structure of ductile metals.

As different forming operations impose different loading conditions on the metallic crystals, the behavior of the crystals naturally is different for each of the various forming operations, and it is difficult, if not impossible, to prove any one alloy to be more formable than another. In the present article the various aluminum alloys are listed in the order of decreasing formability for each of the various forming operations encountered in sheet-metal airframe fabrication.

The numerical values given for the various forming properties, which are based on the limited data now available, should be regarded as of a tentative nature,

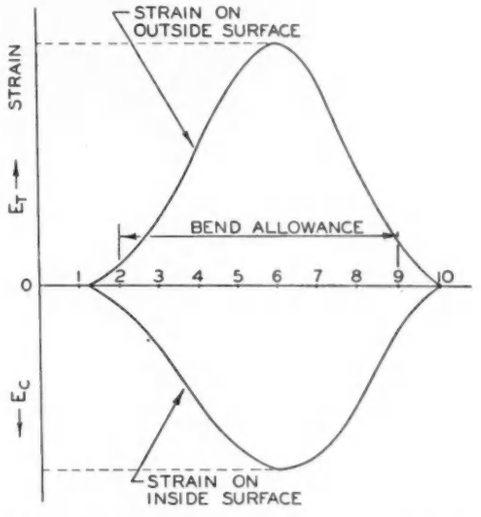


Fig. 2—Distribution of strain around the flange bend.

intended to indicate the performance which may be expected in any particular case, rather than to set definite limits.

Many parts, such as brackets, channels, shear beams, etc., are formed by bending up flanges from a sheet, as

Table II—Stretching

Order of Formability	Alloy	Gage Length	Minimum Values of Elongation Per Cent	Edge Condition
1*	52SO	2"	19–21.5	Polished
	61SW	2"		Polished
	53SW	2"		Polished
	24SO	2"		Polished
2*	24ST	2"	17.5	Polished
	24ST	2"	12.5	Sheared
1	61SW	40"–50"	17.5	Polished
2	53SW	40"–50"	16.5	Polished
	52SO	40"–50"		Polished
3	24SO Alc.	40"–50"	10.5	Polished
4	24ST Alc.	40"–50"	8.5	Polished
1	52SO	40"–50"	13.0	Sheared
2	53SW	40"–50"	11.0	Sheared
3	24SO Alc.	40"–50"	9.5	Sheared
4	61SW	40"–50"	8.0	Sheared
5	24ST	40"–50"	4.5	Sheared
6	52S-½H	40"–50"	3.0	Sheared

* These results are from standard tensile coupons.

Aluminum Alloys

Used in Aircraft Fabrication

Table I—Bending

Order of Formability	Alloy	Minimum Elongation in ¼ in.
1	52SO	37.0%
2	53SW	30.0%
	61SW	
	24SO	
3	24ST	23.0%
4	52S-½H	20.0%

Note: Allowable elongation values decrease somewhat with increasing bend allowance. Above numerical values apply to bending of sheet metal parts within normal limits. Bending of large extrusions is a special case on which information is now being gathered.

shown in Fig. 1. The forming in this case is a simple bending operation. A cross section of the bend (Fig. 1a) shows that this process is one of stretching the outer fibers and compressing the inner ones. Fig. 2 shows the experimentally-determined distribution of strain around the bend on both the inner and outer surfaces. Owing to the phenomenon of high local elongation, which enables a material to withstand very high plastic deformation over short distances without failure, the strains obtainable around the bend are very much higher than those obtained from the ordinary 2-in. elongation average value from a tensile coupon. Consequently, if the "bendability" of a material is to be determined, it is necessary to know its

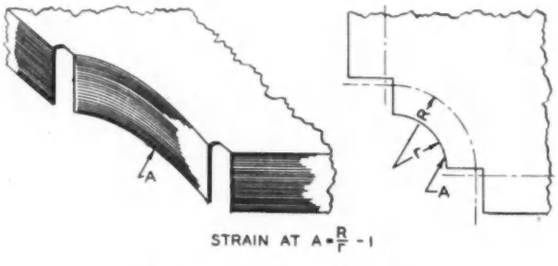


Fig. 3—Internal flange.

behavior over short gage lengths. Listed below are the various aluminum alloys in descending order of formability under pure bending. As the possible influence of the gage (thickness) is not yet determined, Table I gives minimum values experimentally found for gages at present in use. As dimpling for flush riveting is closely allied to local elongation, Table I may be used also for dimpling evaluation.

Lightening-hole flanges and internal flanges are formed by stretching which accompanies bending. Gage lengths of 2 to 10 in. are involved. The stretching is a maximum at the cut edge designated by *A* in Figs. 3 and 4. The alloy which will withstand the greatest elongation without failure with a given edge condition at *A* is the best material for this operation. Because of the support given the outside fibers at *A* by the less-strained inner fibers, several necks may appear at *A* without failure. As a result, stretch-flange maximum elongations have been found to correlate with values of ¼-in. elongation given in Table I.

Contoured skins for fuselage or nacelle coverings, etc., are best formed by stretching either with a rubber punch in a female die (Fig. 5), or by using a male die in conjunction with a gripping ring held in a

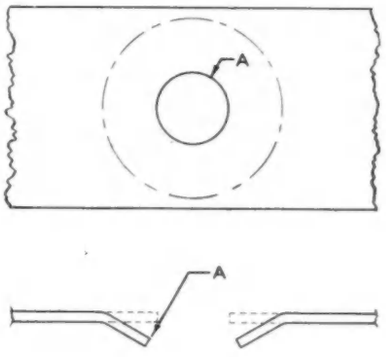


Fig. 4 — Lightening hole flange.

double-acting press (Fig. 6). In either case the skin must be fully restrained at the edge and then stretched to contour. Little or no springback is encountered in this type of operation, and dies may be made to contour without error. The best material for this type of operation is that having the highest elongation over gage lengths of 10 in. or more for the edge condition to be met in practice. Softer materials are easier to stretch in practice, as the edge-gripping problem is less difficult than with hard materials.

Contoured parts having continuous flanges of such shape that forming the flanges requires shrinking of the metal, are most economically formed on a single-acting rubber press, a rubber blanket being used to

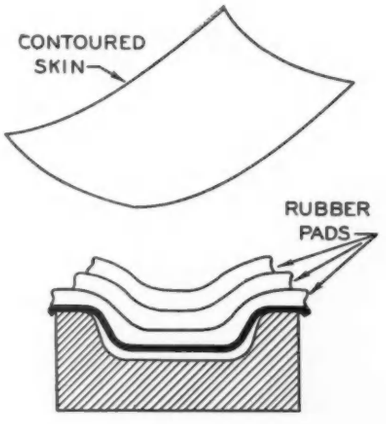


Fig. 5 —Stretching with a rubber punch in a female die.

form the part over a male formblock. The wing rib shown in Fig. 7 is typical of parts that must be formed by shrinking. It is shrunk at the nose and upper flange, the lower straight flange being simultaneously formed by bending. An element of length PB on the edge of the blank must shrink to a length $P'B'$ in the final part. In rubber forming, little support is given the flange during this bending and shrinkage operation, and it (the flange) tends to buckle under the high compressive forces set up in the flange.

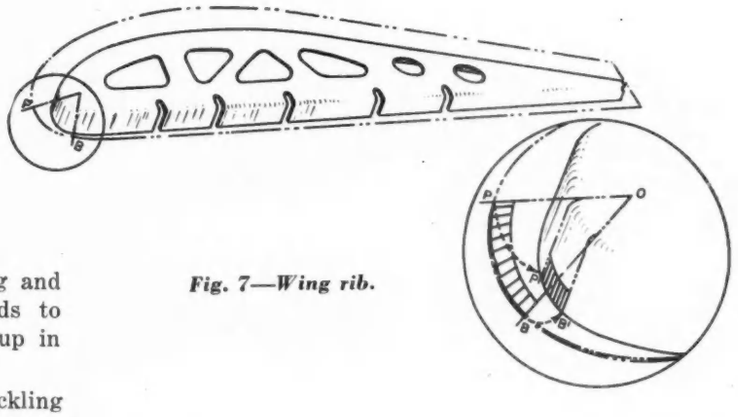


Fig. 7—Wing rib.

The ability of a material to shrink without buckling increases with the thickness of the sheet, and for a given thickness may be assumed to be proportional to the ratio E'/F_{c_y}. The term F_{c_y} is the compression yield stress of the metal, while E' is the tangent modulus in the range of the stress-strain diagram involved in the most critical part of the shrinking process (P to B in Fig. 7). Appendix A gives a derivation of the above relation.

Table III gives the relative ability of the material to shrink without buckling, expressed by evaluating the index $S = E'/F_{c_y}$.

Window frames, junction boxes, deep cups and ribs with very deep flanges (1 in. or more) must be formed

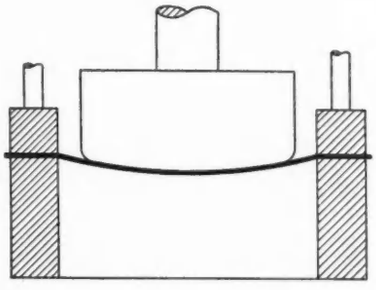


Fig. 6 - Stretching by using a male die with a gripping ring held in a double-acting press.

by drawing. Drawing is similar in its effects on the metal to shrinking, except in degree. Normal shrinking on the single-acting press with rubber punch is limited to the range 2-10 per cent compressive strain, whereas in drawing the compressive strains may be as high as 60 per cent. Unless the sheet is unusually heavy, which is rarely the case in aircraft work, the flanges must be supported by a draw ring to prevent buckling during the shrinking operation. The stress relationship during drawing operations is very complex, and no attempt will be made here to analyze it, this subject being covered in References 3 and 4. However, the combined-stress condition that does exist during drawing operations is very favorable to the production of very high deformations without failure. Using a wedge draw die (Fig. 8), which approximates drawing conditions, several of the aluminum alloys most commonly used have been listed in order of their formability. The criterion of deep-drawing formability is taken as the limiting value of the ratio r/R, where r represents the diameter of a drawn cup and R the diameter of the blank from which it was formed. Fig. 9 shows a number of aluminum alloy wedges and cups drawn to the upper limit of the failure range. The length of the wedge or the depth of the cup is a direct measure of the "drawability" of the alloy in question.

Table III—Relative Shrink Formability

Order of Formability	Alloy	Index $S = \frac{E'}{F_{c_y}}$
1	24SO	13.5
2	52SO	11.4
3	61SW	7.1
4	53SW	5.5
5	24ST	2.9

Appendix

If wrinkling during shrinking is not to be permitted, the critical buckling stress F_{cr} must be higher than the compressive stress $F_{c\,max}$ which exists in the region PB of maximum compressive strain e_{max}. Then the ratio $F_{cr}/F_{c\,max}$ is an index of the ability of the material to shrink without buckling. The more this ratio

Fig. 8 — Wedge draw coupons before and after being drawn in the wedge draw die.

Fig. 9—Cups and wedges of various aluminum alloys drawn to the upper limit of the failure range; one operation.

exceeds 1, the greater is this ability. For convenience this ratio

$$S = \frac{F_{cr}}{F_{c\ max.}} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

may be called the index of shrink formability.

Also, it may be assumed that for most of the aluminum alloys the compressive stress-strain diagrams are roughly similar as regards their general shape, and that, for any given strain e_1, the corresponding stress F_{c_1} bears the same ratio to F_{c_y} for any material, where e_{max} is not greater than 4 per cent.

$$\frac{F_{c_1}}{F_{c_y}} = k \text{ (for a given } o_1) \quad \ldots\ldots\ldots (2)$$

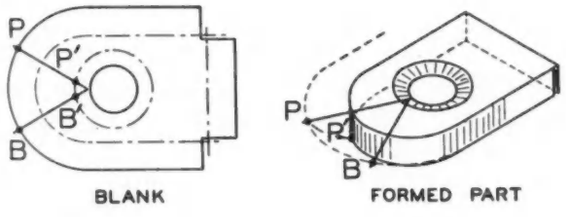


Fig. 10—Typical part requiring shrinking of flange.

Appendix A

For a given part the maximum strain e_{max} is determined by the geometry of the part and will be the same regardless of the material used. If this value e_{max} be used in place of e_1 as a basis of comparison in equation (2), we have

$$\frac{F_{c\ max.}}{F_{c_y}} = k \quad \ldots\ldots\ldots\ldots\ldots\ldots (2a)$$

Substituting equation (2a) in (1),

$$S = \frac{F_{cr}}{kF_{c_y}} \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

In addition for constant thickness,

$$F_{cr} = k'E' \quad \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Substituting (4) in (3),

$$S = \frac{k'E'}{kF_{c_y}} = K\frac{E'}{F_{c_y}} \quad \ldots\ldots\ldots\ldots (5)$$

By properly evaluating K, the critical limit of shrink formability (for which $S = 1$) can be determined in any desired case. However, we are here concerned only with the *relative* formability, and this can be evaluated approximately by assigning K in equation (5) the arbitrary value 1, substituting physical values for E' and F_{c_y}, and arranging the resulting values of S in order of relative magnitude, as is done in Table III.

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Table IV—Relative Formability for Drawing in One Operation

Order of Formability	Alloy	Grain Direction	Gage	Range of Limiting r/R Ratio
1	24SO Alc. (fine grain)	with	.051	.54–.56
		across	.051	.51–.53
		45 deg.	.051	*–.49
	24SO Alc. (moderately large grain)	with	.051	.49–.51
		across	.051	.49–.51
2	52SO	with	.041	.50–.53
		across	.041	.54–.57
	2SO	with	.040	.52–.55
	3SO	with	.040	.52–.54
3	24SW Alc.	with	.032	.55–.58
	3S-½H	with	.040	.56–.59
	53SW	with	.040	.55–.58
		across	.040	.58–.61
		45 deg.	.040	.51–.53
	61SW	with	.040	.55–.58
		across	.040	.58–.61
		45 deg.	.040	.53–.55
	52S-½H	with	.040	.58–.61
		across	.040	.58–.61
4	24ST Alc.	with	.032	.65–.70
		across	.032	.67–.71

* The wedge draw die was not long enough to accommodate specimens having r/R ratios less than .49, hence the lower limit of failure could not be determined for this material at 45 deg. to the direction of rolling.

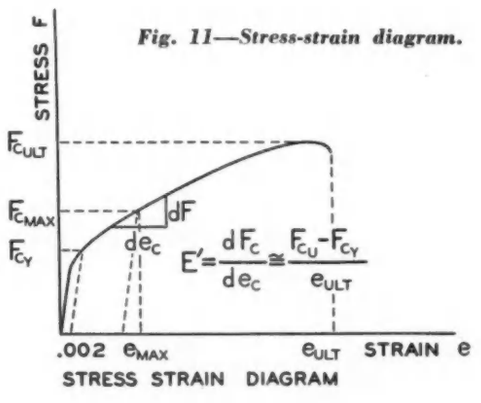
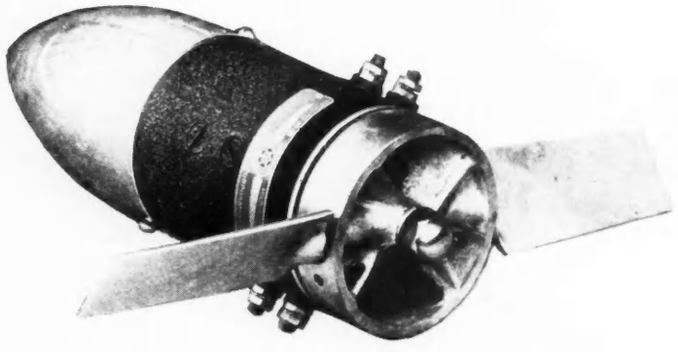


Fig. 11—Stress-strain diagram.

Electrical Equipment for A

EVER since the advent of the large transport plane there has been rapid development in electrical equipment for airplanes. Electric current has been put to many new uses, and the generator capacity required has constantly increased. There is, of course, considerable similarity between the conditions under which current must be generated, and between the purposes for which it is used, in the automobile and the airplane, respectively, and experience in the manufacture of automotive electrical equipment was quite a help in the pioneer days of aircraft equipment; but with the rapid growth in generator capacity required and with new applications of electricity, many new problems have arisen.



Air-lite generator for light planes.

American automobile electrical equipment uses direct current, generally at 6 volts. Direct current is used because a battery is carried and must be charged with current from the generator, and also because one of the principal applications of current is in starting the car engine, which calls for a starting motor of high stalling torque. Of all of the different kinds of electric motors in production, the direct-current series motor develops the highest stalling torque per unit of weight. The reason for the low voltage of 6 is that it reduces battery weight. From other points of view this low voltage is a disadvantage, because it necessitates the use of comparatively heavy wiring. But with automobile equipment the saving in battery weight and cost evidently overshadows the loss due to the heavier wiring required.

Much greater generating capacity is required in a modern transport or military plane than in an automobile and, besides, the restrictions on weight are much more severe in the case of the former. In a large plane, moreover, some of the electrical circuits are much longer than in an automobile, so that the weight of the wiring constitutes a greater proportion of the total weight of the electrical installation. For this reason it was found expedient to adopt a voltage of 12 for aircraft installations at the very beginning, and recently the tendency has been to standardize on a voltage of 24. However, some experimental 120-volt direct-current installations have been made.

The heart of the whole electrical installation is the generator. For airplane use the generator must be as light as possible, yet it must be fully as reliable in service as an automobile generator, for instance, and in the case of military aircraft it is essential, moreover, that its vulnerability be low. For increased reliability of the electric system as a whole, it is now customary to carry at least two generators, while for four-engined transport planes and large bombers, four generators are preferred. All of these generators are operated in parallel. Dividing the total electrical load between either two or four small generators naturally adds to the weight of the installation, but here again the advantage gained, that of reduced vulnerability, warrants the sacrifice in weight efficiency.

In all of the earlier airplanes the generators were driven directly from the main engines, and this is still the prevailing practice. Where a direct drive is used it is necessary to carry a storage battery to supply current when the plane is grounded, for starting the main engine, for radio, etc. Aircraft engineers are rather averse to the use of storage batteries, because of the low weight efficiency of the latter. A typical aircraft storage battery of 12 volts and 750 watt-hours capacity weighs about 65 lb. Two aircraft generators weighing together about as much as the storage battery would generate this same amount of electrical energy in 5 minutes. However, all military planes carry storage batteries, though these are usually quite small. It is necessary, of course, to have electric current available while the plane is grounded, especially in the case of military machines, which are sometimes required to furnish current even for use outside the plane. One possible solution of the problem is the use of an auxiliary generator set, that is, a generator driven by a special gasoline engine. In recent years there has been a great deal of discussion regarding the relative merits of direct-driven generators and auxiliary generator sets, and a good many arguments can be advanced in favor of each type. In one particular case the question arose in connection with a four-engined transport plane as to whether it would be better to use four small generators, each driven by one of the four main engines, or two auxiliary generator sets each of slightly less than twice the capacity of one of the small generators. With the direct-driven gener-

Aircraft— DC Generators

By P. M. Heldt

ators a storage battery would have to be used. In addition to supplying current when the plane is grounded, the battery also can take care of part of the load when a large part of the installed load is turned on at the same time, which is the reason each of the auxiliary units does not need to be quite twice as large as one of the four small generators. The auxiliary units are started either by hand or by current from the storage battery (by placing a motor winding in the generator), and they furnish the current for starting the main engines. One argument against the auxiliary units is that they add considerably to the maintenance problem, for with two such units there are six gasoline engines to be kept in running order, instead of four. The small auxiliary engines, moreover, weigh considerably more per horse power than the main engines, even when they are credited with the weight of the driving gears used in connection with the direct-driven generators. Another argument in favor of the direct-drive installation is that the total electrical load is divided between four instead of between two generators, hence the vulnerability of the installation as a whole is reduced, and this, probably, would be the deciding factor in the case of military machines.

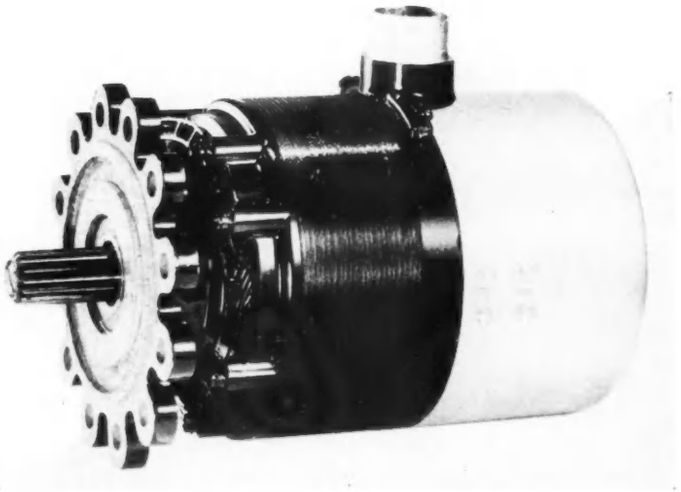
It also has been urged against the use of auxiliary generating units on military planes that the latter now operate mostly at very high altitudes, where the auxiliary engines would lose much of their power, owing to the low density of the atmosphere. Of course, it would be possible to equip these engines also with superchargers, but this is thought to entail undue complication and cost. There are evidently certain advantages in combining a small auxiliary generating set, for use when the plane is grounded, with two or more direct-driven generators, as the auxiliary set could supply current for starting the main engines, thus obviating the need for a large storage battery. The objections based on extra engine maintenance and loss of power at high altitudes would then become void. Actually many military planes are equipped with two generators driven by the main engines, together with a storage battery and an auxiliary generator set.

Electric generators for aircraft are now being made much lighter than some years ago,* and it is interesting to consider the means by which this reduction in weight has been brought about. Generator output is measured in watts, which are the product of the current in amperes by the electromotive force in volts. The current which can be taken from a certain generator is generally limited by the rise in armature temperature which, if it bcomes excessive, is apt to ruin the insulation.

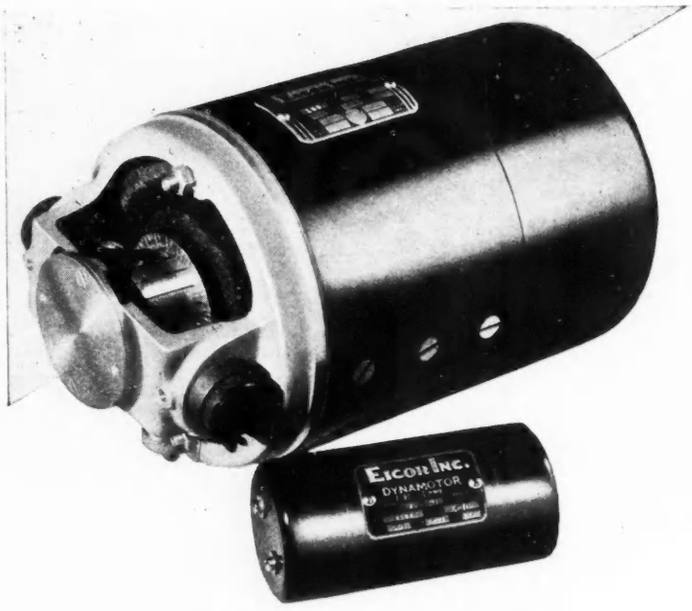
The current capacity of the generator can be increased in any one of three different ways. First of all, the size of the armature conductors can be increased, which reduces their resistance and the heat generated in them by a certain current flow. There is, of course, a limit to the size of the conductors, as any increase in the amount of current-carrying material necessitates a corresponding decrease in the amount of magnetic material, which tends to lower the output by its effect on the voltage generated. But for maximum output from a generator of given weight, the ratio of copper to iron must be comparatively high.

To keep down the armature temperature at high outputs, ventilation or fan cooling is provided. This carries off the heat generated more rapidly, and per-

* In 1936 the U. S. Army specified that 750-watt generators must not weigh more than 31 lb., which corresponds to a specific weight of 41.4 lb. per kw. In 1941 airplane generators were being supplied to the Army which furnished 5.7 kw. and weighed 42 lb., which makes the specific weight 7.38 lb. In five years, therefore, generator weight was reduced in the proportion of 41.4 to 7.38 or 5.6 to 1. Of course, generators of such high specific output cannot be expected to show the same life as automobile generators, but that is not necessary, since the average active life of aircraft is far less than that of the automobile.



Leece-Neville Ni-2 generators.

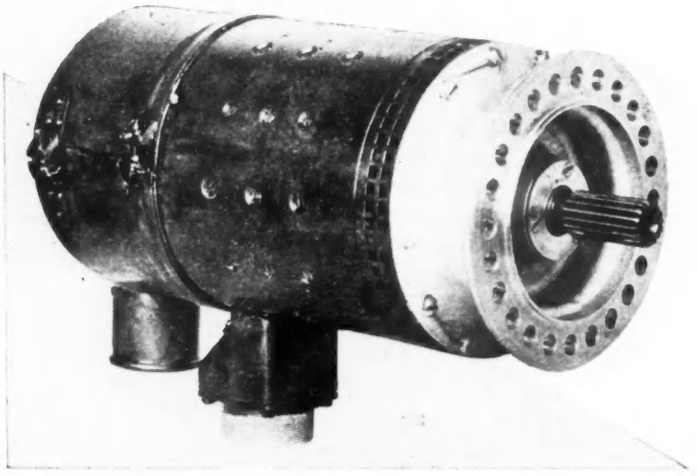


Elcor Dynamotor for use on aircraft.

mits greater output for a certain limiting temperature rise. The full-load continuous output of a generator is dependent on the rate at which ventilating air passes through it. The 5.7 kw generator referred to in the foot note as having been supplied to the Army in 1941, is provided with a 2-in. blast tube which supplies air to the generator under a pressure of 10 in. of water column. Finally, insulating material of mineral origin, such as mica, asbestos and glass fiber, can be used, which will safely withstand higher operating temperatures than the conventional insulating materials. More intensive cooling and more heat-resisting insulating materials both permit of higher current densities in the armature conductors. Much better insulating compounds and improvements in making electrical connections also permit higher current densities. Armature leads generally are brazed to the commutator bar, instead of being soldered to them.

The other factor in the output of the generator is the voltage, which is proportional to the rate at which magnetic lines of force are being cut by the armature conductors. Thus the voltage evidently depends upon the density of the magnetic field in the air gap and the peripheral velocity of the armature. A high armature peripheral velocity is necessary to high output, and both the rotative speeds and armature diameters generally are greater in aircraft than in automotive generators. To obtain a high magnetic density in the air gap we must use magnetic material of high permeability. However, barring the discovery of new magnetic materials, there does not seem to be much chance of improving greatly on the magnetic densities used in conventional electrical machinery. But to put a given magnetic flux through the air gap with the minimum weight, the length of the individual magnetic circuit must be made small. This points to the use of multi-pole generators.

The schematic diagram show a two-pole and a six-pole generator field, both of the same outside diameter. In the two-pole field there are two magnetic circuits, in the six-pole, six. The total magnetic flux, which is cut twice by each armature conductor during one revolution, is that which can be carried by one pole piece in the two-pole and by three pole pieces in the six-pole machine, and it is obvious from the diagram that the total flux will be greater in the six-pole machine. Looking at the matter from a slightly different angle, the magnetic flux is directly proportional to the total cross sectional area of the magnetic circuits, while the weight of the magnetic structure is proportional to both the cross section and the length of the magnetic circuits, and it is plain from the diagram that the length of each magnetic circuit is much less in the case of the six-pole machine. There is, of course, a limit to the number of poles which can be used to advantage. With an increase in the number of poles the number of field windings, armature and commutator sections and commutator brushes will have to be increased, and the optimum number of poles for any given set of conditions is a matter for judgment based on experience.



General Electric aircraft generator.

There is a practical limit also to the peripheral velocity of the armature, because the centrifugal force subjects the armature conductors to severe stresses, especially those portions located outside the armature slots or tunnels. Aircraft generators at present operate through a speed range of approximately 2500-4500 rpm. A 4-in. armature at 4500 rpm has a peripheral velocity of nearly a mile a minute, and the conductors near its surface are subjected to a centrifugal force approximately 1250 times the force

of gravity. Some generators are being used which have an operating speed range of 4000-12,000 rpm.

Commutator diameters also must be held within reasonable limits, as the heat generated by friction between the brushes and the commutator increases in direct proportion to the rubbing speed. Too high a rubbing speed results in excessive brush wear. A 5.7 kw generator of 28 volts delivers a current of 200 amperes, and it takes considerable contact surface to carry such a large current. Brushes evidently must be selected with a view to low contact resistance, so that both the contact area and the contact pressure may be kept moderate, and current densities, although higher than usual in industrial practice, must not be excessive. It has been found that brush wear is abnormally high in high altitudes. This is believed to be due to the low oxygen and water contents of the atmosphere at these altitudes, which retards the formation of an oxide film on the surface of the commutator and promotes abrasion.

Practically all of the parts of the generator which do not perform magnetic or

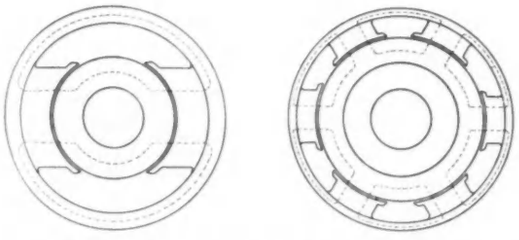
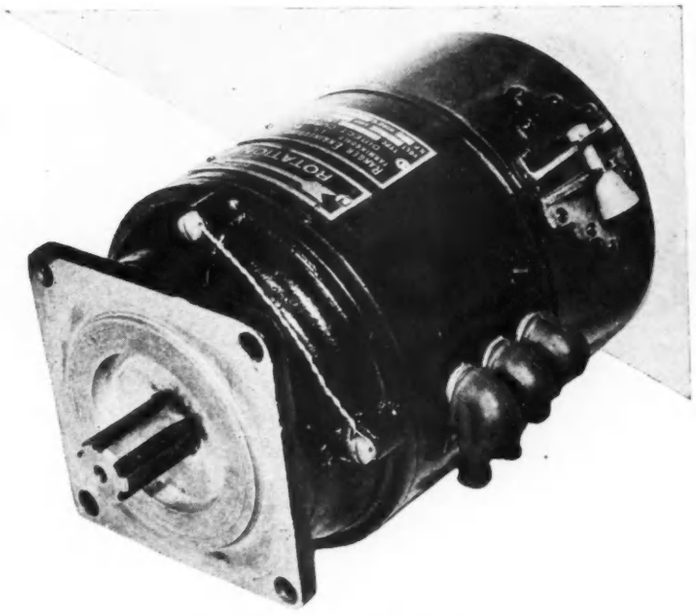


Diagram of the magnetic circuits of two-pole and six-pole generators showing the length of the individual circuit to be much greater in the former.

electrical functions can be made to advantage of light alloys, and magnesium or aluminum alloys are the most suitable materials for the end plates or cover plates. However, there has been some trouble with brushholders made of aluminum, which have a tendency to corrode in a moist atmosphere, in which case the brushes will stick in them and not function properly. On the other hand, it is contended that such corrosion will occur only if the conventional zinc-chloride flux or a similar acid flux is used in soldering the brush shunts to the holders. Electrographitic brushes will not stick in aluminum brushholders if the use of such fluxes is avoided. Where trouble has been experienced due to the corrosion of aluminum brush-holders, these generally have been replaced by either brass or stainless steel holders. Aside from this, the Army requires the use of steel mounting flanges for all generators weighing in excess of 34 lb.



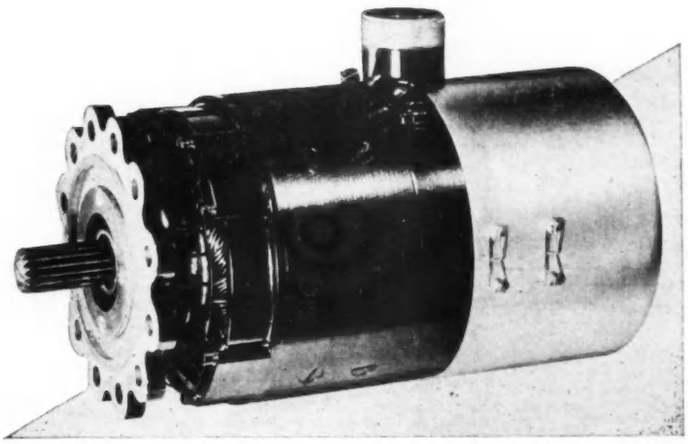
Ranger Aircraft Generator.

Following are output and weight data for a number of aircraft generators developed in recent years:

1940: 3 kw 12-volt generator, 32 lb.
1940: 5 kw 28-volt generator, 50 lb.
1941: 5.7 kw 28.5-volt generator, 42 lb.

There is one further limitation on generator design in the case of generators to be driven from main engines, and that is the overhang moment. This is the product of the weight of the generator into the distance between its center of gravity and the plane of the mounting flange, on which a definte limit is usually placed. Too large an overhang moment evidently would be likely to overstress the mounting or supporting members in case of severe bumps, etc.

Aircraft generators generally are driven through some kind of flexible coupling to minimize inertia stresses and to compensate for a possible slight misalignment between the driving and driven shafts. One of these flexible couplings comprises a member made of synthetic rubber which is vulcanized or bonded to the metallic coupling member.



Leece Neville O-1 Generator.

Applications of the

In Automotive *and* Aviation Industry of June 1 we dealt with the use of electric strain gages in the development of aircraft structures, on the basis of an S. A. E. paper by C. R. Strang of the Douglas Aircraft Co., Inc. In that article the working principles of the electric strain gage were explained and general rules were given covering methods of application of the instrument in the determination of strains in aircraft structures. In the latter part of his paper Mr. Strang dealt with specific problems to which the strain gage has been applied by the Douglas research organization.

There is first of all the familiar problem of the distribution of combined direct and torsional shear stresses in a multi-spar stressed-skin wing. The stress distribution in such a wing is represented diagramatically by Fig. 1A, where the combined shears are plotted vertically on a base represented by the contour of the wing section. This stress is of importance because its magnitude and distribution largely determine the wing thickness, the spar-web thickness, the stiffener arrangements required, and the rivet patterns for seams in the wing covering. Methods of calculating these stresses are rather involved, and a check on their accuracy is highly desirable.

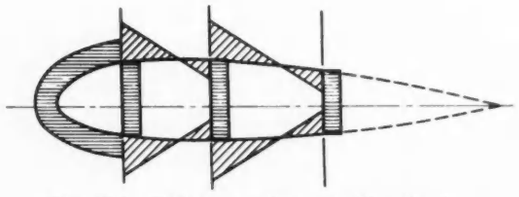


Fig. 1A—Diagram of stress distribution in a multi-spar stressed-skin wing

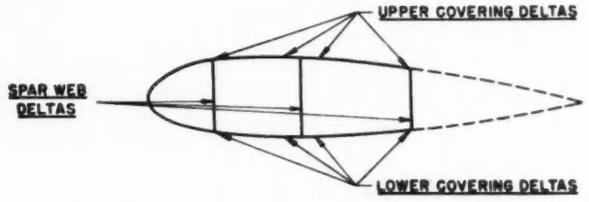


Fig. 1B—Location of strain deltas for the determination of strain distribution in multi-spar stressed-skin wing

At any particular cross section of the wing, strain deltas can be installed at all points of maximum shear stress, on both the wing covering and the spar webs. They should be arranged as indicated in Fig. 1B. With the type of wing sketched, this would call for 12 deltas or 36 channels, and this multiplicity of channels restricts the scheme to static or laboratory test work.

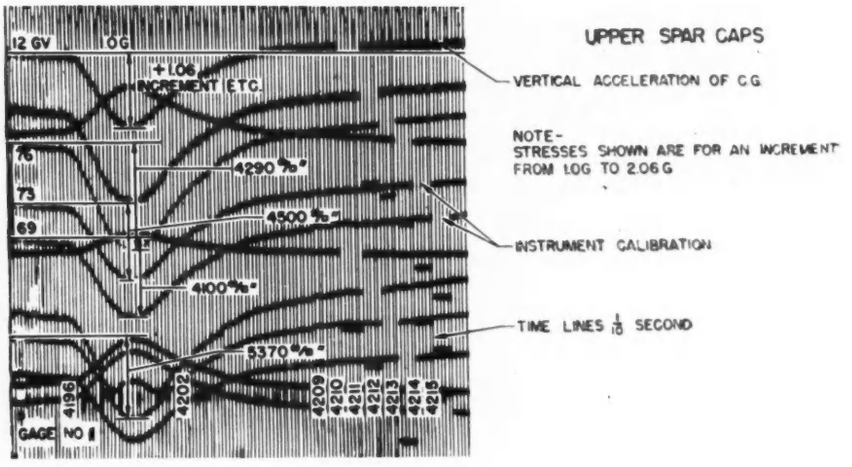


Fig. 2—Oscillographs showing stress variation at upper spar caps during a sharp pull-up

In calculating such a stress distribution, the usual procedure is to distribute the direct shear among the spars in proportion to the spar-web area. This procedure is justified by the fact that in a monocoque wing the torsional deflections are small. The air pressure on the wing, which acts at its center of pressure, produces a torsional moment about a spanwise axis of the wing. The magnitude of this moment depends on the distance of the center of pressure from the axis selected. For convenience, the elastic axis, defined as the locus of points about which no angular deflection would occur if load were applied to them, is the usual reference axis. The corresponding torsional moment is then distributed between the various torque boxes (three in Fig. 1) in proportion to their torsional rigidities. Finally, the shear stresses in the wing covering involved in carrying the bending loads to any bending material located between the shear webs are calculated. All three shear stresses are combined to give the typical pattern of shear-stress intensity in Fig. 1A. This procedure, therefore, involves determination of the elastic-axis position in order to establish the value of the torsional moment.

So far, agreement between the results of calculations and tests has not been satisfactory. Since the axis location is not accurately known, the practice

Electric Strain Gage

in the solution of aircraft structural design problems

has been to define a range of chord positions within which the axis should lie, and to design the wing structure for the loads implied by the two extreme positions. However, this method not only is laborious, but results in heavier design than would be necessary if the location of the axis were accurately known.

Starting with the strain-gage data derived from an installation as shown by Fig. 1B, it is possible to work in the opposite direction, separate the various contributory shear stresses, and arrive at the true shear center or elastic axis. The ability to determine the actual shear distribution by the use of a shear delta on the wing covering adjacent items of bending material should accelerate the development of a mathematical treatment suitable for various engineering applications.

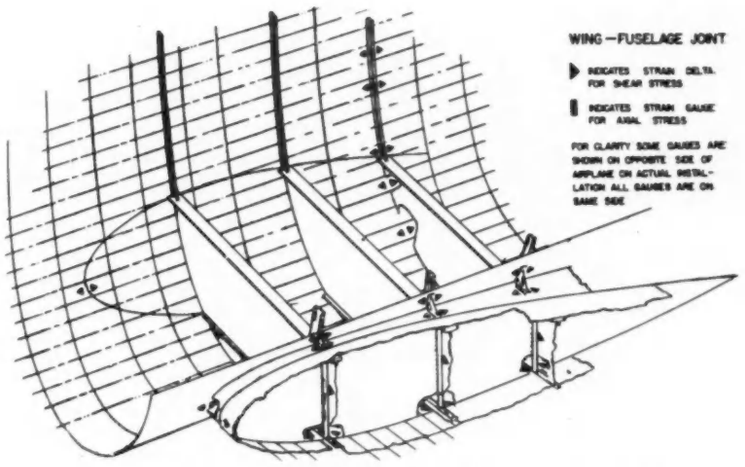

WING—FUSELAGE JOINT
INDICATES STRAIN DELTA FOR SHEAR STRESS
INDICATES STRAIN GAUGE FOR AXIAL STRESS
FOR CLARITY SOME GAUGES ARE SHOWN ON OPPOSITE SIDE OF AIRPLANE ON ACTUAL INSTALLATION ALL GAUGES ARE ON SAME SIDE

Fig. 4—Diagram showing location of strain gages and deltas in a study of stress transfer between wing and fuselage

Recently there has been growing concern over the effects of compressibility on such items as the aerodynamic twisting moment imposed on the wing at speeds approaching the velocity of sound. So far the increases predicted by theory have not evidenced themselves in flight tests. It is now planned to use a simplified strain-gage installation to measure the magnitude, and especially the variation in magnitude, of the moment with dive speed.

Another basic problem is to substantiate the broad assumption that the simple bending theory applies to a beam of the complicated cross section of a typical multi-spar cantilever beam. Presumably spars are forced to conform to the wing-deflection curve (as distinct from their individual curves) by the torsional rigidity of their outer covering and the stiffness of the ribs. Actually this assumption does not hold completely, and some independent motion of spars does occur. However, such independent spar action is likely to become important only where the spar arrangement is made discontinuous to provide room for retractable landing gears or an opening for bomb bays, etc. Assumptions must be made as to the behavior of the spars under load, and the structure designed on the basis of these assumptions becomes a function of the assumptions themselves.

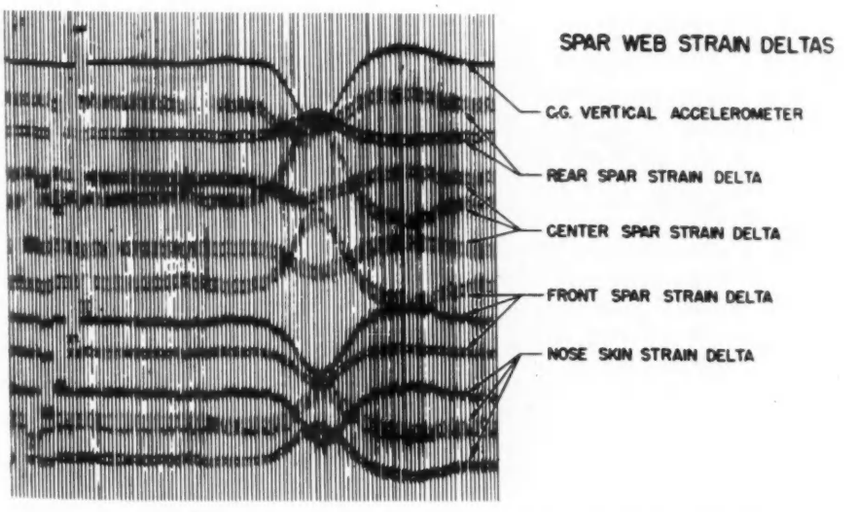


Fig. 3—Oscillograms showing stress variation in spar webs during a sharp pull-up

One very complicated problem of this nature has been investigated in flight. In this case the state of stress of several critical cross sections of the wing in the affected area was determined by data from average-reading strain-gage installations on each spar cap and strain deltas on each spar web. By comparing the results

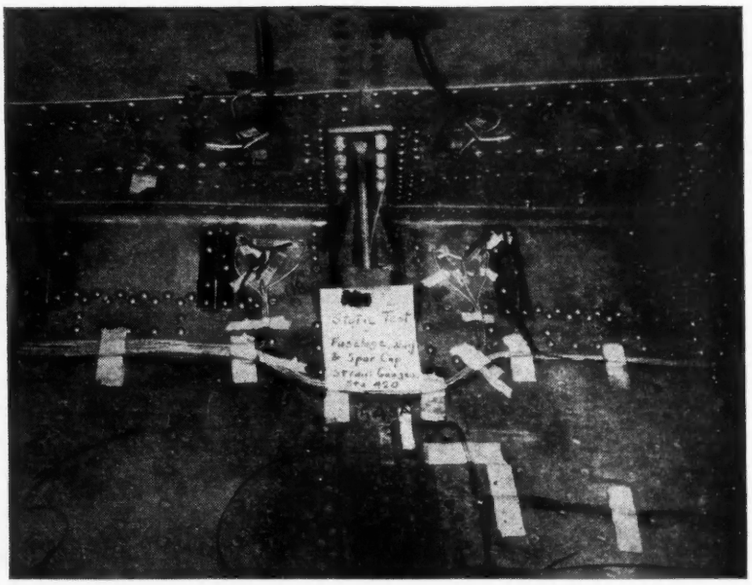


Fig. 5—Installation of strain gages and deltas for the study of stress transfer between wing and fuselage

with calculated stresses and by making changes in the original design assumptions, a better understanding of the behavior of the entire assembly was obtained. If such work is carried out on an experimental airplane, redesign for production, taking account of the usually greater power and greater weight that must be provided for, can be carried through more rapidly and with greater precision.

Fig. 2 is a part of the records obtained in this particular investigation. The traces showing stress variations in the upper spar caps at one section of the wing have been marked, together with some auxiliary data. They show the entire history of events in a sharp pull-up, one of many made in these tests. The magnitude of the stress at any point and at any instant is indicated by the departure of the trace from its steady-flight base. Fig. 3 is another part of the data typical of records of strain deltas on the spar webs under the same conditions.

One of the basic problems always facing the designer is that of the nature of the transfer of load between wing and fuselage. In large all-metal designs, in addition to fittings between the spars and fuselage frame, there usually is a continuous shear connection between wing covering and fuselage skin. If it were not for this shear connection, the magnitude of the reactions at the fittings would be a simple problem in statics. The usual procedure is to make "overlapping" assumptions as to the proportion of the torque load carried directly by the wing to the fuselage fittings and that carried by direct shear from the wing covering to the fuselage skin. The problem is of particular importance whenever it is desired to keep the interior fuselage space free from obstructing bulkheads. This means that loads transferred to the fuselage by the fittings are actually carried by ring frames, which usually are shallower in depth than the designer would like to have them.

Precise knowledge of the actual nature of the load transfer therefore determines the general proportions of the wing-to-fuselage fittings, the spar frames, the fuselage skin in the neighborhood of the wing intersection, and the rivet patterns in the area. Usually the problem is further complicated by the presence of windows, doors and emergency hatches in the affected part of the fuselage.

Part of the investigation covered by the set-up shown in Fig. 6 of the previous installment was concerned with this problem, the test set-up being shown diagrammatically in Fig. 4. For the sake of clarity, some of the gages are shown on the opposite side of the fuselage from the wing, while in the actual set-up they are all on the same side. Strain deltas at critical points in the wing-shear system just outside the fuselage, on the fuselage skin adjacent to the wing intersection, and close to the spar frames, together with a number of gages sufficient to determine loads imposed on the spar frames immediately above the wing fittings, permit a precise determination of the nature of the load transfer. Fig. 5 is a photograph of a part of the actual installation. By comparison with Fig. 4 it will be recognized as the region on the upper wing surface at the root of the center spar.

The resulting information serves to check the assumptions that have been made for the purpose of design; it permits of a more intelligent revision of the design when an increase in load-carrying capacity is called for later; permits a more accurate solution of shop salvage problems that may occur in the affected

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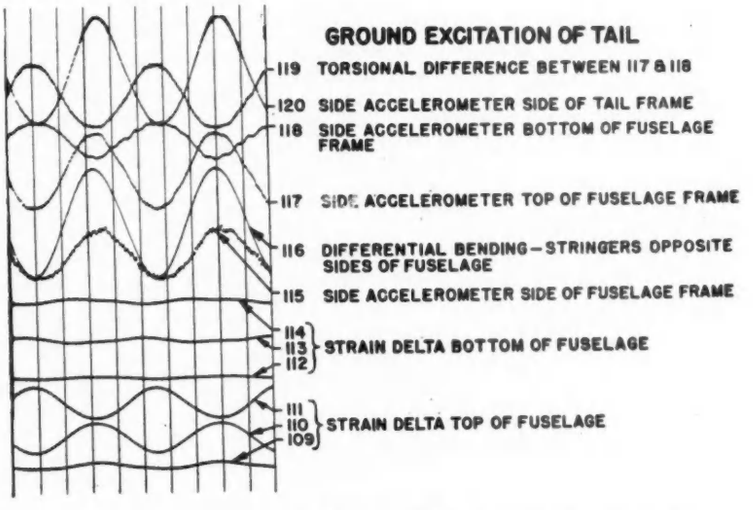

GROUND EXCITATION OF TAIL
119 TORSIONAL DIFFERENCE BETWEEN 117 & 118
120 SIDE ACCELEROMETER SIDE OF TAIL FRAME
118 SIDE ACCELEROMETER BOTTOM OF FUSELAGE FRAME
117 SIDE ACCELEROMETER TOP OF FUSELAGE FRAME
116 DIFFERENTIAL BENDING—STRINGERS OPPOSITE SIDES OF FUSELAGE
115 SIDE ACCELEROMETER SIDE OF FUSELAGE FRAME
114
113
112
STRAIN DELTA BOTTOM OF FUSELAGE
111
110
109
STRAIN DELTA TOP OF FUSELAGE

Fig. 6—Oscillograms taken during the investigation of strains due to oscillation of an airplane tail in flight

Airbriefs

By HENRY LOWE BROWNBACK

Wood Airplanes

Our British Allies have scored another bulls eye with the new de Havilland "Mosquito" plane. You will remember that, about a year ago, AIRBRIEFS deplored the lack of interest in all-wood fighting planes in view of European experience and predicted that all wood fighters would be on the scene before the war was over. This prediction has been confirmed by the Mosquito which is not only an outstanding all-wood airplane but in addition is the world's outstanding light bomber and one of the world's fastest aircraft as well. Incidentally this ship shows the value of long distance air races as the Mosquito is a lineal descendant of the "Comet" which won the air race from England to Australia. If stories which are circulating can be believed the mosquito is a living demand for the radical overhauling of our aviation specifications as practically all of the material which enters into its construction is subject to rejection under our present regulations.

Why Do They Do It?

I have occasion to go over many designs for airplane assemblies covered with light metal or thin plywood and I am astounded by the lack of adherence to the most elementary principles of making a surface to pass through a fluid with a minimum of resistance shown by most designers.

Instead of placing the stringers which support the surfaces parallel to the airflow they insist on placing them normal to this flow so that the thin surface washboards and sets up all sorts of inefficient airflows over the surfaces.

That Focke-Wulf Fighter

The Focke-Wulf Fighter which had been heralded as something almost superlative has been subjected to a very close scrutiny by the British, who have captured some in flying condition. While it is not a "super" plane as far as speed and climb go it is a formidable fighting weapon having a battery of cannon and guns which can throw 610 pounds of projectiles per minute.

The machine has several features which are notable. It is the first continental fighter of its speed to be equipped with a radial air-cooled engine and its two inboard cannon are synchronized to fire through the propeller. Many details of interest are incorporated in the pilot's compartment, the first being the pilot's seat which is well protected by armor plate varying from 8 to 14 mm in thickness. The seat itself is tilted to minimize any tendency for the pilot to "black out" in a dive and the pilot's cockpit covering can be jettisoned by pressing a button which fires an explosive charge in the fastening that cuts the canopy loose. This is torn off by the airstream taking the back armor with it. The pilot then rolls the machine on its back, which frees him. As he falls his chute, which forms the back cushion of the seat, is automatically opened.

The pilot can clear the entire chute and its shrouds by striking a button on his chest and his seat cushion is made from his collapsed life raft. On striking the water he can inflate the raft and his life preserver by striking another button. Dropping into water with a jacket having a high degree of flotation produces an enormous shock on the pilot but if he drops into the water clear of his chute and inflates his jacket and raft after submergence there is no shock of any consequence. These are a few of the details of this most interesting machine.

Blower Cooling

The Pratt and Whitney-like BMW aircooled radial engine used in the Focke-Wulf, Dornier and Blom and Voss planes has a blower to cool it during climbing and wide-open operation. This feature, eliminating gills, and its cowling design have made it the world's outstanding example in the elimination of engine drag according to British authorities. One of the old Navy flying boats and some of the Army's early tractors were equipped with "Vee" type Renault engines having blower cooling which worked perfectly. These planes were designed by W. Starling Burgess and built at the Burgess Company and Curtis at Marblehead, Mass. I shall always remember the trial trip of a flying boat which embodied many novel and advanced features. Burgess and I took off in it for its first flight (and it was my first test flight). He sat in the rear cockpit just under a large wheel which was used to crank the engine. As he had never flown a machine using what is now the accepted type of elevator and much more sensitive than the old Wright type, he over-controlled at first and on one of the swoops which resulted, the cranking wheel fell off and hit him on the knitted seaman's cap which he always wore. Excepting for top speed the old K36 Burgess would be a fine sport plane today.

Trouble

Recently the OWI released some information about American fighting planes which was "news" to those outside of the industry, but a matter of common talk in the industry. The interesting part of the whole thing is that the types of planes in which we excel are derivatives of commercial airliners and those in which we are deficient are fighters. If we want to be fair we will not blame the industry as it excels in that type for which sufficient money has been available to achieve perfection and are laggard in the types for which a log-rolling, pork barrel Congress and an Administration more concerned with social "reform" and industry regulation than military preparation failed to provide funds.

Steam

Every-so-often someone pops up with a steam power plant idea for airplanes with the old story that steam engines are more reliable than gasoline engines. It may surprise many people to know that steam plants of more than 2000 hp. have been built experimentally and, unless my memory fails me, the Navy once spent considerable money on such a development. Up until now questions of weight, economy and resistance have prevented the steam plant from becoming used and the performance of some of our modern gasoline engines makes one doubt that any high speed steam engine would be more reliable.

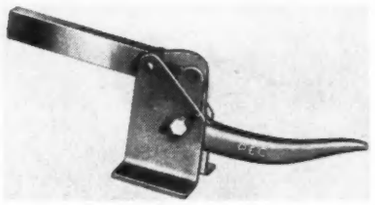
Telephones

Recently I was struck with a scheme employed in a plant I visited making large airplanes. The workmen employed on various jobs were fitted with headset telephones so that they could talk to each other without shouting or leaving their work. This is very ingenious and certainly will find its way into many industries. The Army has a little sending-receiving radio set which can be held in one hand and which is good for several miles. These will also be used in many places after the war.

New Production

A LINE of jig clamps that can be locked in an infinite number of positions, up to 15 degrees above or below horizontal, is now in production at Products Engineering Corporation, Los Angeles, Calif., and marketed under the trade name Pec.

A slotted aperture, which functions much like that found on a pair of combination pliers, makes the infinite adjustments possible. Besides the self-adjusting feature, Pec clamps have a positive lock, are quick-acting, and are of drop-forged construction. The new features are available in many different types of clamps.



The Pec self-adjusting jig clamp.

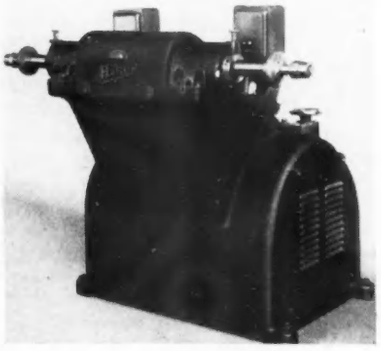
A SPECIAL Machine for milling valve clearance pockets in aircraft-engine pistons was designed and is being built by Snyder Tool & Engineering Co., Detroit. A production of 100 pieces per hour at 85 per cent efficiency was projected, and the machine is said to have a production three times that of a single-spindle machine because it completes both cuts in one setting.

The two milling spindles are mounted in taper roller bearings and individually driven through V belts. An axial adjustment of 1 in. for cutter position and for tool wear is made possible by the quill-type construction. Indexing is by means of a standard Snyder three-station Geneva index mechanism, an electrically-powered self-contained unit. A heavy index-positioning pin enters the locating bushings automatically after indexing.

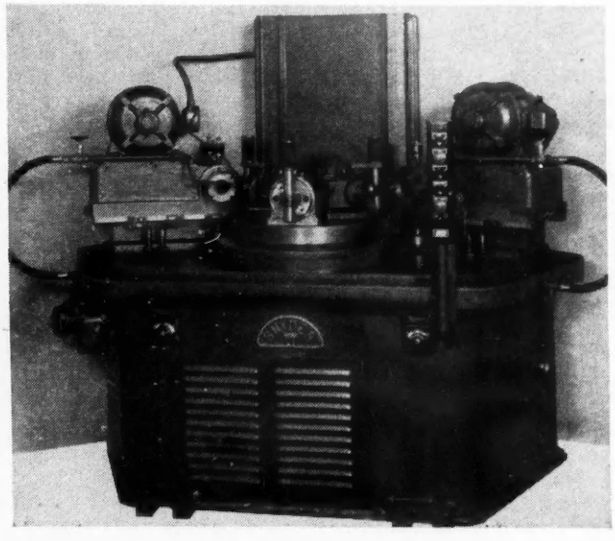
The machine has a welded steel base, within which the hydraulic equipment is housed. Coolant is contained in a resevoir in the rear of the machine, the cover of which serves as a removable chip tray. The piston is positioned by means of a pin entering the piston-pin holes and is clamped by a simple cam action in the fixture. Operation is semi-automatic and is such that after loading the fixture a push button must be pressed for each cycle. In the work cycle, the indexing operation is followed automatically by an infeed of the cutters into the work. While one piston is being loaded, the other two have successive cuts performed on them.

IN a new heavy-duty polisher and buffer offered by the Hisey-Wolf Machine Company, Cincinnati, Ohio, the motor is placed inside the base, which permits of the use of standard open motors in place of completely-enclosed, fan-cooled motors, which results in a saving of scarce materials. The machine is built in a single-spindle, single-motor type as well as in the two-spindle, two-motor type illustrated, and is equipped with motors of from 3 to 10 hp. rating. Constant-level type oilers are fitted. While the illustration shows open spindles, the encased type also can be furnished. In these, a housing surrounds the spindle extension, with a ball bearing adjacent to the wheel.

AT THE Mineral Ridge (Ohio) plant of the Federal Machine and Welder Company, Warren, O., boring machines are assembled which are used in turning out turrets and turret rings for "tanks." Some ninety sub-contractors provide the material and do a large portion of the machining necessary to the completion of these machines, and in some cases the full capacity of the sub-contracting firm is made use of. Planning for the production of these machines was under the direction of Malcolm S. Clark, president and Chas. H. Whittier, factory manager of the Federal Machine and Welder Company.



Hisey-Wolf heavy duty polisher and buffer.

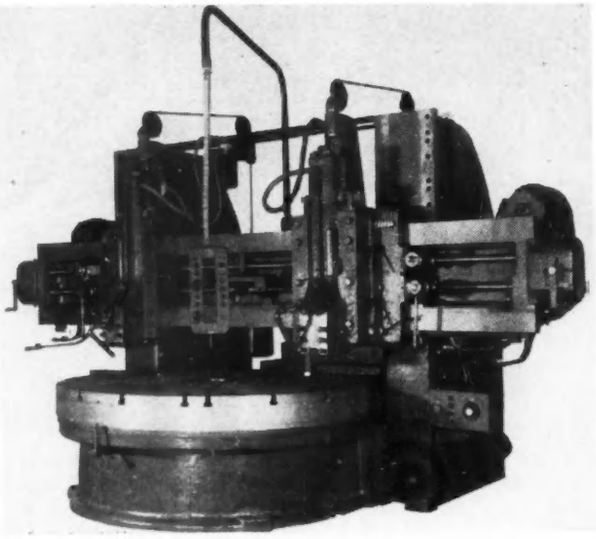


Special Snyder machine for milling valve clearance in aircraft engine pistons.

assisted by Roy Barefoot, engineer of the Dana Street plant, and William Maloney. Each machine covers a floor space of 196 sq ft, is nearly 15 ft high, and weighs 110,000 lb. Two different models are being made, one with a capacity of 100, the other of 112 in. These boring mills are being shipped on Government instruction to tank manufacturers in the U. S. and Canada.

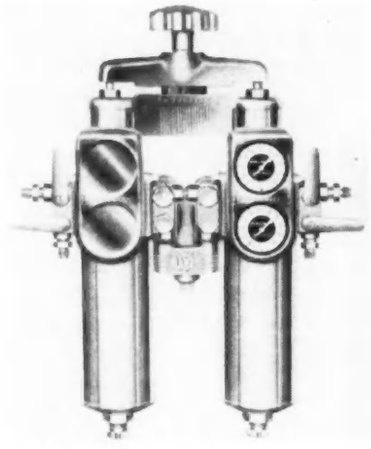
TWO new products have been announced by the DeVilbiss Company of Toledo, Ohio. One is a high-capacity

Equipment



Federal boring machine for tank production.

air transformer of the double barrelled type designated at HLC and capable of delivering 100 CFM. The two pressure regulators are controlled simul-



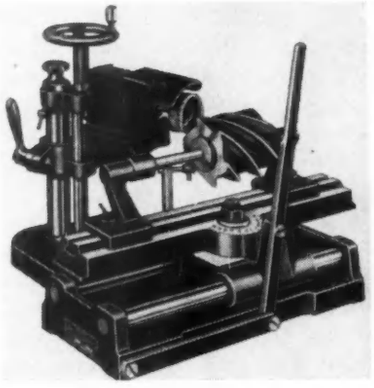
De Vilbiss heavy duty air transformer.

taneously by a single knob, although both function independently. The filtering and condensing mechanisms are of the all metal type requiring no replacements. The quick acting diaphragms are of reinforced, oil-proof synthetic rubber. Connection to the main air line is made at a single inlet port. The other new product is designed for automatic shell coating with a wide adaptability in finishing operations. It automatically paints bombs, grenades, shell, shot and cartridge cases in sizes from 20 to 155 mm. Each unit is engineered specifically for a particular job.

A NEW Hilco universal cutter grinder, announced by the Berco Manufacturing Co., Chicago, is furnished with an interchangeable table or flat-bed attachment, and with a special universal index dividing head. It is claimed for this grinder that it can be set up in a few minutes for any type of cutter to be ground, regardless of what cutter was ground last. It will grind concave, convex, helical, straight, tapered, angle or special cutters up to 6 in. diameter, and saws up to 18 in. diameter, regardless of the cutting angle required.

The dividing head, a special feature of the Hilco, has seven index circles and is claimed to ensure complete uniformity of cutting edges in the finished cutter. The grinder can be quickly set up to accommodate any type of cutter. It is a bench-type machine—21 in. long, 17 in. deep, and 17 in. high, and it weighs approximately 135 lbs.

NEW lightweight equipment designed to hold freight securely in place in cargo planes and to simplify and speed up loading and unloading of the cargo, is announced by Evans Products Company, Detroit, Mich. For permanent installation in planes, perforated tubing is used. Four tubes are installed longitudinally, one at each side attached to ribs in the roof of the cargo compartment and two in the floor, attached to floor posts. To these longitudinal tubes are fastened adjustable vertical members, to which can be fastened tubular cross members. The cross members can be pressed downward on the cargo, exerting sufficient pressure to prevent movement of the load they are designed



Hilco Universal cutter-grinder with table attachment.

to hold. In addition to the air cargo hold-down equipment described above, the Evans Products Company makes several other types.

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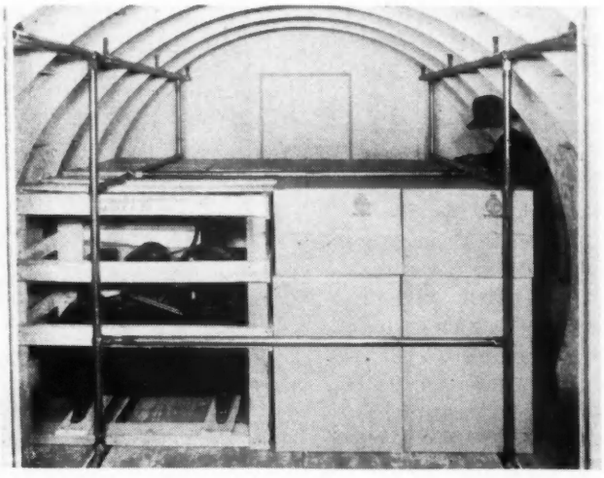


Evans air cargo hold-down equipment.

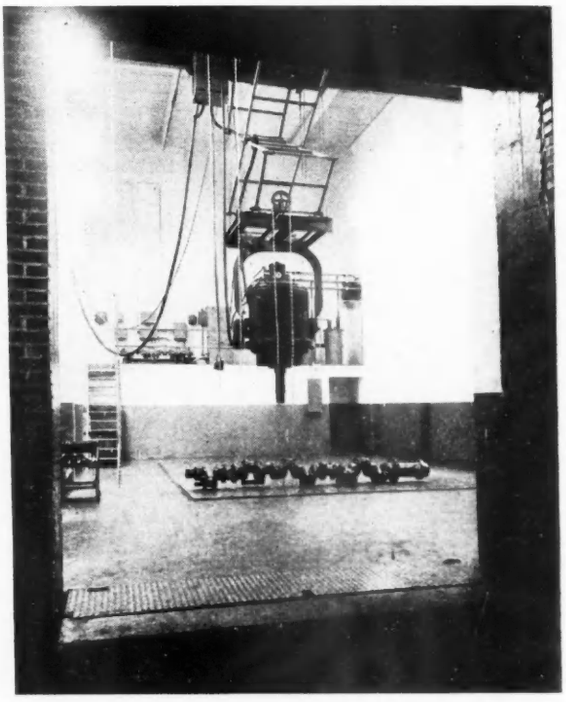
X-Ray Technique

Aids Development Work at the Campbell-Wyant-Cannon Foundry

STRIKING evidence of the progressiveness of the Campbell-Wyant-Cannon Foundry Co., Muskegon, Mich., is found in the establishment of the new X-ray laboratory boasting one of the few one-million-volt General Electric X-ray machines to be found in this country. This equipment is capable of exploring a 10-in. section of steel. In essence, the X-ray at C-W-C is used both for research and for trouble shooting. It is employed in the development of huge crankshafts which are a specialty at the foundry and it has been found invaluable in foundry development work on all intricate castings where soundness is dependent upon the exact location of gates and risers.

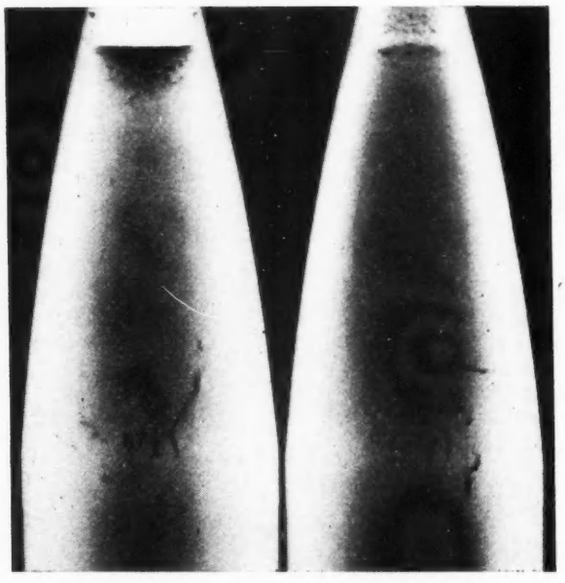
In the accompanying photograph is shown the interior of the X-ray room, with the X-ray machine in the foreground. A maze of 18 in. thick concrete walls separate it from the control room and darkroom. The X-ray head is swung in a pantagraph support and can be angulated 360 deg vertically, and horizontally through 180 deg. The tube protrudes from the bottom of the shell, and has a transmitted beam as well as a reflected beam, thus making it extremely flexible. A self-contained water system helps cool the freon gas inside the head, and also furnishes cooling water directly behind the tube target.

The walls of the room are 18 in. concrete up to 14 ft, and then 12 in. for the remaining distance. This concrete was poured continuously, to prevent cracks. A 24-ton concrete filled door which slides to one side, allows trucks to drive into the room. From these trucks 10-ton castings can be lifted with an auxiliary crane not shown in the photograph. There are 1600 watts of fluorescent illumination in the X-ray room. The X-ray tube covers a usable area on the floor of approximately 15 by 25 ft. The room overall is approximately 30 by 45 ft, and 25 ft high inside.



View of Campbell-Wyant-Cannon X-ray laboratory showing the X-ray head and its pantagraph support in the center.

An example of X-ray investigation is illustrated here. It shows radiographs of two 155-mm percussion type shells. The shell at the left (with cap) was made of stainless steel and showed no visible indication of surface defects. The shell at the right showed surface cracks by Magnaflux inspection. X-ray examination clearly indicates a spongy structure due to internal shrink. Near the center are shrink cracks probably aggravated by improper coring or extreme hardness of cores.



Radiographs of two 155-mm shells. Both indicate spongy structure at top due to shrink, and shrink cracks at center probably aggravated by improper coring. Original photograph was retouched to make defects visible in this reproduction.

A series of tests was made to determine the best type of gate and riser practice for producing sound gear blanks. The X-ray film showed the original form of gated pattern caused shrinkage cracks in the vicinity of the riser. Gating and risering were progressively altered and improved until sound gear blanks were produced free from shrinkage and porosity.

Potentially the X-ray

(*Turn to page* 86 *please*)

The McGay

Tubeless Tire

THE McGay tubeless tire, now being tested by various rubber companies, local and state highway departments, is really an inflated passenger car tire of any standard make without the inner tube. The setup, which is shown in the accompanying illustration, is quite simple as there are only two major requirements to make it work—the wheel rim must be of the drop center type and the valve, which is mounted in the hole formerly occupied by the tube valve stem, should be a truck valve of the metal type.

The man behind this particular type of tubeless tire is John B. McGay, timing instrument manufacturer of Tulsa, Okla., who reports that he tried for several months beginning the latter part of July to interest various Government agencies connected with the rubber crisis in the idea as a means of rubber conservation, but met with no success. The millions of inner tubes in the hands of the public also would provide many thousands of tons of high grade scrap for the nation's rubber stockpile, he points out.

Mr. McGay conducted experiments for months to substantiate his claim and now makes the following recommendations for eliminating the inner tube in a passenger car tire or a light truck tire, providing the latter is mounted on a drop center rim. The casing and tube are removed from the rim and the former inspected and repaired if there are any small holes or fabric breaks in it. He advocates the use of one to two quarts of any good tire sealing fluid in the casing to eliminate any small holes that might not be detected, but in the case of new or nearly new casings this precaution is not necessary. The inside of the rim also should be cleaned thoroughly and the section where the bead contacts the rim made smooth. If there are any rough places or corrugations on the bead, they should be sanded down or ground off with a small emery wheel. Then a truck tire valve is inserted in the hole of the rim as shown in the drawing at the left of the illustration.

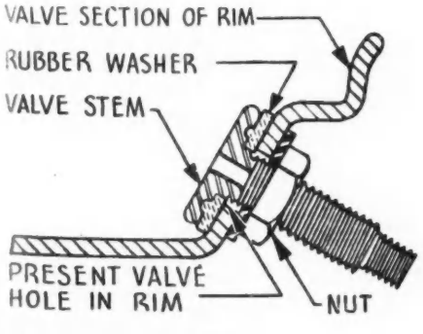
After the casing is mounted on the rim, the wheel is supported as shown in the center drawing. It is important that the outside tire bead be pressed as far as possible on the rim shoulder. Next the valve core is removed and the air applied, at the same time beating on the casing with a mallet to make the inner bead contact the rim and form a seal. As soon as the casing snaps into place on the rim, the valve core is replaced and the tire inflated to normal pressure. A cross section view is shown in the illustration.

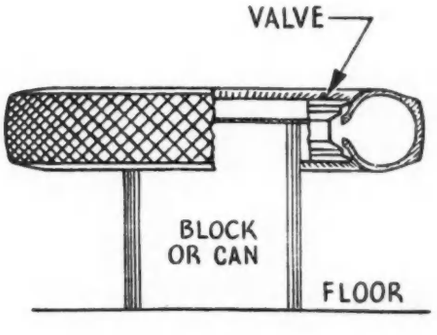
Demonstration of this type of tubeless tire was made before the Lea Oil Investigating Committee of the House on Dec. 1 in Washington. A standard passenger car casing, wheel, tire irons and air compressor were moved into the hearing room to show the spectators the trick of making the conversion. Among those present were McGay, Victor F. Barnett, chairman of the Tulsa War Transportation Committee, which took over the idea to promote it nationally after McGay got nowhere with Government agencies; C. M. Emmons, superintendent of the District of Columbia Municipal Garage; and William R. Boyd, Jr., chairman of the Petroleum Industry War Council.

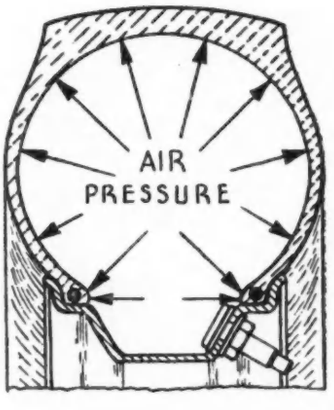
Mr. Boyd, preliminary to the demonstration, told the committee that he had been skeptical of the tubeless tire, but that it had thoroughly impressed him and the other 72 members of the Council early in November at the Council's Chicago meeting when McGay and Barnett demonstrated it. He told the Committee that since then about 1000 oil company cars have been equipped with tubeless tires using casings of various ages and now tests are being made under all sorts of conditions. It is expected that each car will have gone about 2000 miles by Dec. 20 when the tests are scheduled to end and that a report probably will be made before the end of the year.

Mr. Emmons reported that he has been driving his car with tubeless tires for two months and added that a number of vehicles with tubeless tires are being driven by District of Columbia officials, one car having gone 1000 miles and several others 800 miles. While this test was held not to be extensive enough, Mr. Emmons said that there had been no trouble with the tires.

In and around Tulsa, Mr. McGay states, several hundred cars have been equipped with more than 600 tubeless tires and some of these have been tested under every imaginable condition, including speeds as high as 95 mph and air pressures ranging from 12 to 37 lb. Not a single failure has been reported to McGay. At the time of this writing, officials of Kansas, Texas and other states approved the making of tests with hundreds of State-owned cars.







Automobile Plants Now Producing Arms at Rate of $7 Billion a Year

Shift from Defensive Strategy to Attack Causes Slash in Some Schedules While Others Are Boosted

The anniversary of Pearl Harbor found the automotive industry producing war materials at a rate of $20 million per day. This translates into an annual rate of $7 billion, which is 75 per cent greater than the dollar volume of the industry's best peace-time year, 1941. In the first 10 months of 1942 the automotive industry delivered armaments estimated at $3,454,000,000, according to the Automotive Council for War Production. October shipments, the latest month available, were estimated at $527,000,000, a gain of 7½ per cent over September war deliveries. This compares with a little more than $100,000,000 of military equipment shipped by automotive plants in December, 1941, indicating more than a five-fold increase since Pearl Harbor.

Backlog of war orders held by the automotive industry was estimated at $14 billion as of Nov. 1. War production of automotive plants at that time was computed as 49 per cent aircraft engines, airframes, parts and equipment; 20½ per cent military vehicles and parts, 14½ per cent tanks, 3.6 per cent ammunition, 5.4 per cent guns and equipment and 5.6 per cent marine equipment. Due to changes in strategic considerations since that time after the opening of the North African campaign, some of these percentages may have been altered with the recent realignment in production schedules.

War production in 1942 is estimated at 49,000 airplanes, 32,000 tanks and self-propelled artillery units and 17,000 anti-aircraft guns of greater than 20 mm. size according to Office of War Information. This compares with goals of 60,000 airplanes—including 45,000 combat planes—45,000 tanks and 20,000 anti-aircraft guns set by President Roosevelt last January. An increasing proportion of aircraft production is made up of heavy bombers, which helps account for the discrepancy there. In addition to the tanks and self-propelled artillery—tank destroyers—many thousands of scout cars and half and full-track carriers have been produced, all essential to a well-rounded mechanized force, according to OWI. Dollar volume of munitions and war construction for 1942 is estimated at $47 billion by OWI.

The automotive industry is now producing airplane engines, airframes and parts at an annual rate of $2,250,000,000. When the Ford bomber plant, the Dodge-Chicago aircraft engine plant, the General Motors bomber plant, the expansions at the Allison Division of GM, the Nash-Kelvinator aviation engine facilities, and the new Continental Aviation and Engineering plant come into full production, this figure will be greatly increased.

In the year since Pearl Harbor, the automotive industry produced tanks, military vehicles and parts equal in value to the cost of equipping 57 armored divisions, each of which is composed of 3314 motorized units. The Military Vehicles Division of the ACWP, having as members the plant managers, engineers and service experts of 29 automotive companies building 60 different types of military vehicles, works out standardization plans to reduce the number of replacement parts required for field maintenance of these vehicles. Twenty-nine battery types have been reduced to five, two types of spark plugs and generators replace eight previous types, and three types of fan belts are used instead of eight.

(*Turn to page* 50, *please*)

Plans Completed for Giant Plane to Carry 400 Passengers

Production of the Air Mammoth Could Begin Now; Plane Production Estimated at 60% of Capacity

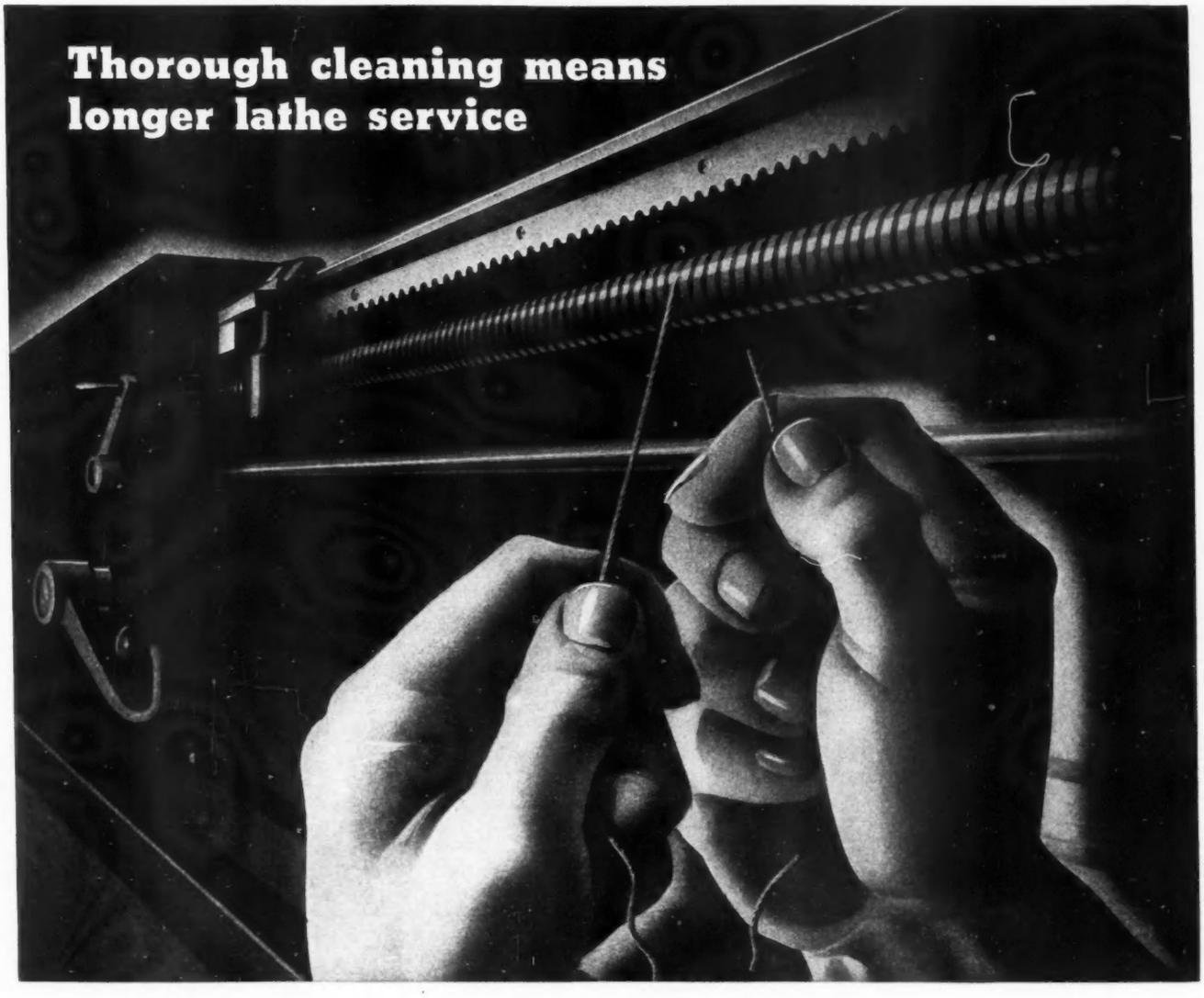
Plans of his engineers for a huge bomber-transport plane that could speed to Europe in a few hours with a crew and 400 passengers have progressed to a point where production could be started at once, Tom M. Girdler, chairman of the boards of Consolidated Aircraft Corp., Vultee Aircraft, Inc., and the Republic Steel Corp, disclosed to the Chamber of Commerce of the State of New York Dec. 3. The new plane, he said, would make the Consolidated B-24 Liberator bomber and the big PBY flying boats look like toys. Its range, he added, would enable it to bomb Europe from bases in this country.

The estimated load-carrying capacity of such a plane would far exceed that

(*Turn to page* 58, *please*)

On the African Front

Assault gun mounted on a tank chassis and manned by steel-helmeted American soldiers, is shown as it rumbled toward the front in North Africa. The big gun is a "tank killer" while the gun at upper left is a heavy-caliber machine gun. This unit was recently tested in the deserts of the Southwest and was said to have proved its effectiveness. A picture taken during the tests was published in Automotive and Aviation Industries for Nov. 1.



Information supplied by an Industrial publication

In cleaning lathes it is common practice to brush chips, dust, and dirt off lathe ways and surfaces, spindle threads, and other obvious places.

There are other parts where cleaning is equally important, but that are likely to be overlooked. One is the lead screw, and the other is the interior threads in the chuck or face plate back.

The former can be effectively cleaned by holding a cord, or piece of twine of suitable diameter in the thread groove, and pulling the ends back and forth as the screw revolves. The motion is similar to that used in polishing shoes.

Interior threads can be cleaned by a simple tool made out of a piece of heavy steel wire. The wire is bent into a loop, with the ends bent at right angles. The tool works better if the ends are filed to the V-shape of the threads, the spring in the loop will hold the ends tightly in the thread grooves.

CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.
MOLYBDIC OXIDE—BRIQUETTED OR CANNED • FERROMOLYBDENUM • "CALCIUM MOLYBDATE"

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MOLY

Absenteeism Declining Slightly In Most War Production Plants

Abolishment of Premium Pay for Saturday and Sunday Work Reduces Time Lost; Strikes Continue

Absenteeism still is a factor in reducing output in war plants but the number of absentees has declined since the presidential decree abolishing premium pay for Saturday and Sunday work went into effect Oct. 1. Prior to that date, employes would take a day off during the week and then make it up with the time and one-half and double time that prevailed for weekend work in most plants. But now an employe must work six consecutive days to collect time and one-half pay for the sixth day and seven consecutive days to be paid double time for the seventh day.

However, absenteeism still persists. A recent survey of 151 Cleveland plants employing 45,541 workers showed absenteeism of 6.6 per cent on a Monday. In individual plants the absentee rate varied from 2 to 10 per cent. One plant employing 6,750 had 802 men out. Monday probably would show more absentees than any other day. Short term absenteeism in General Motors plants has doubled in the last 15 months. Lost time rates in various GM plants range from 2 to 7 per cent. A 5 per cent loss may cut production as much as 15 per cent due to the absence of key individuals and specialists.

High hourly rates and much overtime are responsible for some of the absenteeism. Workers receive such fat pay checks that they are willing to take a day or two off to spend their money on recreation. In GM plants averaging 40 to 55 hours per week, there is no tendency for high absenteeism to be associated with longer hours. However, British experience has shown that where the work week exceeds 60 hours, absenteeism registers an increase. This is also true on 7-day operations as com-

(*Turn to page* 56, *please*)

New Synthetic Plant

Designed to use butadiene made from alcohol, a new synthetic-rubber plant is now ready to begin production, it has been announced by John F. Collyer, president of the B. F. Goodrich Co. The new plant is located in Kentucky.

SAE Meeting Hears Papers on Air Cargo

Aviation and transportation men attending the Air Cargo Engineering Meeting, held at Chicago, Dec. 8 and 9, under the auspices of the SAE, heard papers on phases of the engineering and economic aspects of post-war cargo shipments by air. R. D. Kelly, of United Air Lines, Chicago, was general chairman.

Three sessions were held the first day, the first being devoted to airline cargo problems, the second to air-cargo operations, and the third to a discussion of air-borne war transport by the armed services. On the closing day, the final session was given over to discussion of the design of cargo planes, and the final session to cargo gliders.

Producing Arms at Rate Of $7 Billion a Year

(*Continued from page* 48)

With the recent shift in emphasis from defense to offense in U. S. war strategy, marked by the land, air and sea campaign against the Japanese in the Solomons, the opening of the North African front and the recent advances in New Guinea, there is a changing demand for war equipment. This is illustrated by the experience of the Fisher Body plants at Pontiac and Flint, which have been tooling up to produce 90-mm anti-aircraft-guns, both of the mobile and stationary types. When the contract was awarded last February, it appeared that the U. S. might need to defend its coastal cities from enemy aircraft with these guns. In 10 months the strategic situation has vastly changed and materials like alloy steel are more urgently needed for offensive weapons. Under the original contract, Fisher Body was scheduled to produce its first gun in December and to reach peak output in June, 1943. But, due to the ingenuity of automotive engineers, the first gun was completed last June and full protection would have been achieved in December but for two recent cutbacks in the schedule. This curtailment has necessitated a 25 per cent reduction in the working force, releasing the men for more urgent war production assignments.

Fisher Body is building the gun and mounts on automotive production-line methods. More than 20,000 in. of welding go into the completed gun assemblies. Four thousand parts have to be assembled. Production has been cut to a fraction of projected 1943 schedules but can be boosted at least 300 per cent any time the government says the word and allows the proper allocation of materials.

Another GM plant, the Saginaw Steering Gear Division, also has had to curtail production schedules and lay off a few workers due to its efficient manufacture of machine guns. This plant has provided the armed forces with so many machine guns of a certain type that there is no more need for such weapons at present. However, production is going forward on other types of weapons.

The Chrysler Tank Arsenal, which is turning out M-4 medium tanks on five assembly lines, also has had its future schedules reduced. Output there could be upped by 20 per cent if the needed material and machines were made available, according to a Chrysler official. Instead, the government is reviewing the armament needs and the material available with a view to cutting projected output goals in 1943. Another manufacturer scheduled to make armored cars on a volume basis has had the order drastically reduced even though tooling was virtually complete. Steel for armor plate and other uses cannot be spared. Engine makers for military equipment likewise have had their schedules greatly curtailed.

Aircraft, ships and landing boats are getting the green light for materials and production. Some new plants and plant expansion has been halted, such as the $45 million ordnance plant under construction at Hammond, Ind. But new plants for making aircraft, synthetic rubber and high octane gasoline are being rushed to completion.

Industry has done a better job on war products than was expected, according to C. E. Wilson, president of General Motors. The increase in dollar volume of shipments really is greater than shown by the figures due to the renegotiation of contracts. Wilson says that the impact of new facilities has not yet been fully felt, but in another six months this should cause a marked advance in war deliveries, especially in aircraft. General Motors' armament shipments for October totaled $248,405,560, a 17 per cent gain over September and a greater volume of sales than in any peace-time month. Employment also reached an all-time high.

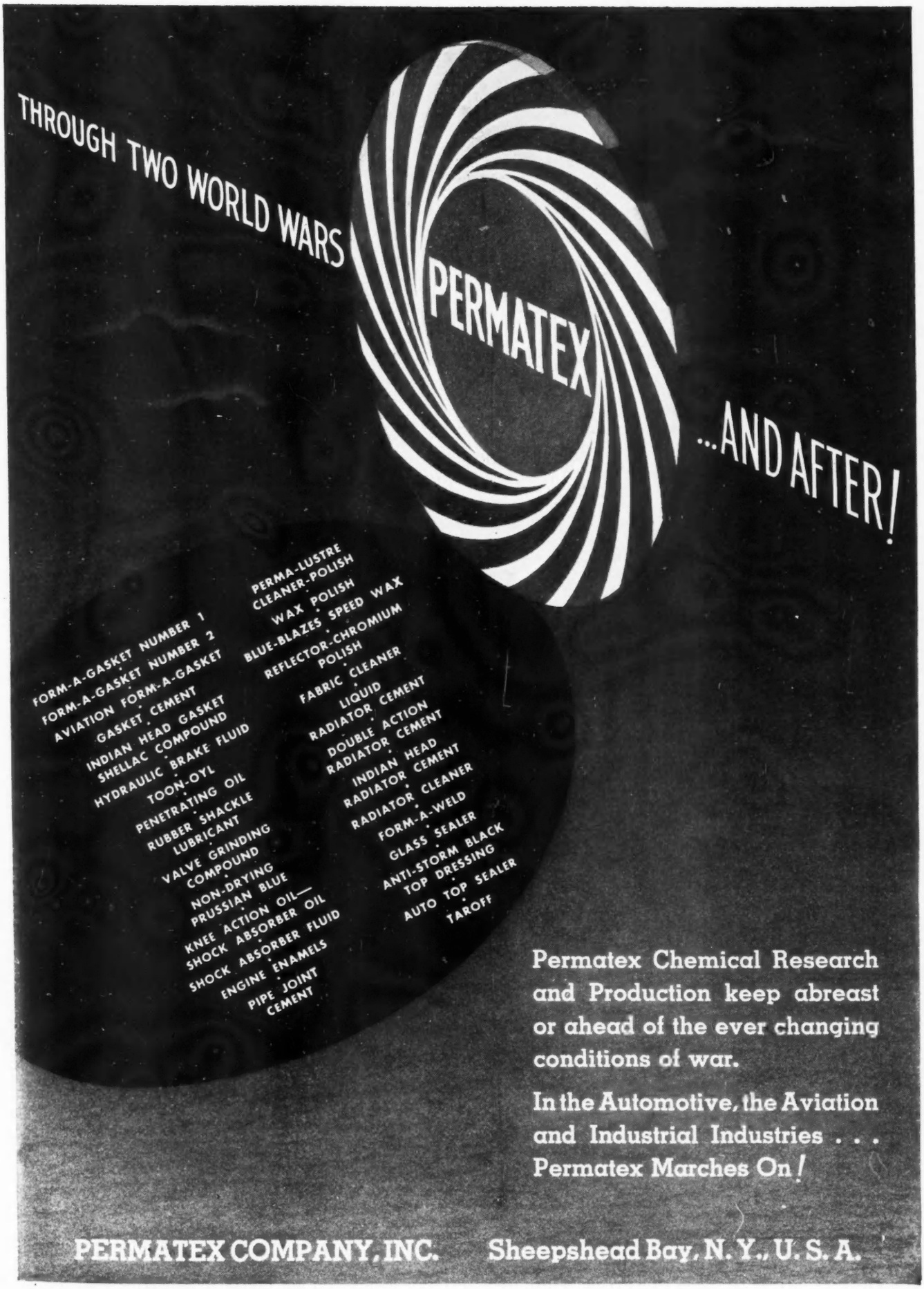
For the past several months the GM backlog has shown no increase, shipments just about balancing new orders. Fifty per cent of GM contracts are for aircraft. Realignment of contracts, due to changing strategy, is not expected to cause any widespread disemployment in the industry. Many plants can reduce schedules by dropping from a seven or six-day basis to a five-day work week or from three to two shifts. However, Ford just stepped up its operations at the Rouge plant from a five to six-day basis. The entire war production figure is a matter of balancing material available against the most vital military needs of the moment.

CALENDAR

Conventions and Meetings

SAE War Engineering-Production Mtg., Detroit ..... Jan. 11-15

American Foundrymen's Association, St. Louis, Annual Mtg..... April 28-30


THROUGH TWO WORLD WARS
PERMATEX
...AND AFTER!
FORM-A-GASKET NUMBER 1
FORM-A-GASKET NUMBER 2
AVIATION FORM-A-GASKET
GASKET CEMENT
INDIAN HEAD GASKET
SHELLAC COMPOUND
HYDRAULIC BRAKE FLUID
TOON-OYL
PENETRATING OIL
RUBBER SHACKLE LUBRICANT
VALVE GRINDING COMPOUND
NON-DRYING PRUSSIAN BLUE
KNEE ACTION OIL—SHOCK ABSORBER OIL
SHOCK ABSORBER FLUID
ENGINE ENAMELS
PIPE JOINT CEMENT
PERMA-LUSTRE CLEANER-POLISH
WAX POLISH
BLUE-BLAZES SPEED WAX
REFLECTOR-CHROMIUM POLISH
FABRIC CLEANER
LIQUID RADIATOR CEMENT
DOUBLE ACTION RADIATOR CEMENT
INDIAN HEAD RADIATOR CEMENT
RADIATOR CLEANER
FORM-A-WELD
GLASS SEALER
ANTI-STORM BLACK TOP DRESSING
AUTO TOP SEALER
TAROFF
Permatex Chemical Research and Production keep abreast or ahead of the ever changing conditions of war.
In the Automotive, the Aviation and Industrial Industries . . . Permatex Marches On!
PERMATEX COMPANY, INC. Sheepshead Bay, N. Y., U. S. A.

Obituary

Albert Kahn, 74, noted architect and builder of many of the automotive industries' factories, died suddenly Dec. 8 at his home in Detroit. He was head of the architectural firm of Albert Kahn, Inc.

Frederick Van Vorhees, vice-president and general sales manager of the Driver-Harris Co., Harrison, N. J., died Nov. 16 at New York, after a brief illness. He had held the same offices in the company since 1925, when Driver-Harris absorbed the Electrical Alloy Co., of which he was vice-president and general manager.

D. A. Keating, chief engineer of the Stanley Works, New Britain, Conn., died Oct. 20.

George H. Hunt, 55, for many years a manufacturer's representative in the automobile industry, died Nov. 26 at his home in Birmingham, Mich. He was active in the introduction of shatterproof glass and the coincidental lock in the automobile industry. He held an interest in the Anderson Mfg. Co. until his retirement in 1940. He was a member of the SAE.

William S. Farish, 61, president of the Standard Oil Co. of New Jersey, died suddenly Nov. 29 at Millbrook, N. Y. He was a former president of Humble Oil Co. He joined Standard Oil Co. of N. J. in 1933 and was elected president in 1937.

Limit Reclaim Inventory

Under an amendment to Order M-15-b, consumers of reclaimed rubber are limited to a 45-day working inventory. The order previously had limited inventories of all other types of rubber. The new amendment does not apply to inventories in the hands of reclaimers.

Wickwire Develops Automatic Propeller

Wickwire Spencer Steel Co., New York, has started production of its new development, an automatic variable pitch propeller, which it is making in quantity for military training planes. While it is impossible at the present time to give details of the design, the company states that "eliminated are all electrical, hydraulic or mechanical equipment and circuits for changing the pitch." Because it has no power pitch-changing mechanism, the Wickwire automatic propeller is said to be simpler and lighter than other variable-pitch propellers of the same size. Owing to this simple design it can be sturdily built and it is claimed to be easily serviced. At the present time the blades are made of wood.

Postpone Aeronautical Chamber Annual Meeting

The annual meeting and election of officers of the Aeronautical Chamber of Commerce of America has been postponed to Jan. 22, it was announced Dec. 3 following its regularly scheduled annual meeting at its headquarters in New York City. It is understood the Chamber is being reorganized and that a definite plan will be presented at the January session.

Christmas Full Holiday

Christmas will be observed as a full holiday in the war industries, Donald M. Nelson, chairman of the War Production Board, has declared. It will be the first such full holiday observed this year.

Powder Metallurgy Developments

The Amplex Division of Chrysler Corp. is currently producing 6000 different powder metal parts for war equipment. More than 4 million man-hours and 1.25 million pounds of critical metal have been saved in the company's production of 40-mm. anti-aircraft guns alone by powder metallurgy. Recent developments have greatly increased variety of form and possible weight of parts. The oil-impregnated, bronze powder bearing in the illustration weighs 61½ lbs.

CENSORED

An exclusive feature prepared by the London correspondent of AUTOMOTIVE AND AVIATION INDUSTRIES, M. W. Bourdon.

Tests made by the Research Committee of the Institution of Automobile Engineers of a gasoline truck engine using various compression ratios between the normal 4.7 to 1 and 16.3 to 1 with producer gas as fuel have shown that whereas the engine gave 75 b.h.p. at 2100 r.p.m. with gasoline at normal compression, the maximum obtainable with producer gas at the same compression was 37.5 b.h.p. at 1750 r.p.m. With a compression of 14 to 1 the maximum output with producer gas was obtained, viz. 51 b.h.p. at 2000 r.p.m., most of the increase being obtained as the compression was raised between 8 and 10 to 1, for at higher compressions mechanical losses and detonation tended to nullify the gain. Practical considerations, therefore, show that about two-thirds of the normal power from gasoline can be obtained from producer gas if the compression is raised to rather less than 10 to 1, against only about half power if the compression is unaltered from the gasoline standard.

To prevent wasteful running in general and to make the best use of tires, fuel, labor and replacement parts, the Ministry of War Transport will control all truck transport where goods are carried 60 miles or more, though control may be applied later to short-distance traffic and vehicles. It is estimated that about 25,000 trucks will be affected immediately.

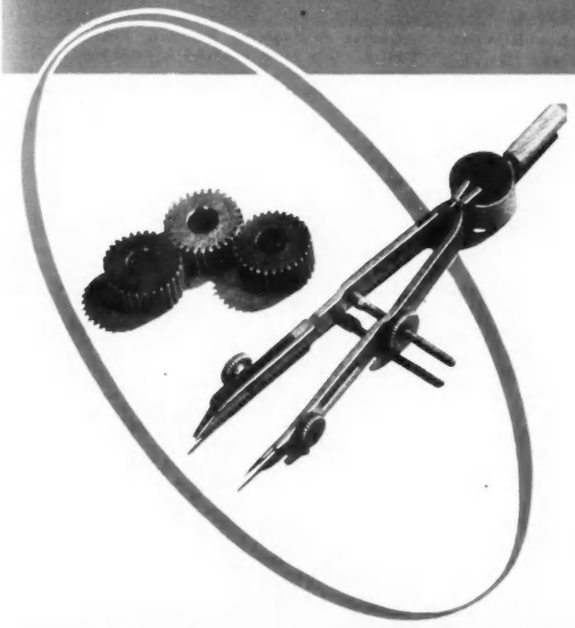
The Ministry of War Transport has put into service the first three of a number of mobile demonstration vans that will tour the country in charge of expert operators to instruct repairshop foremen and mechanics in ways and means of reconditioning worn and fractured components that ordinarily would be considered fit only for the scrap heap. The equipment of each van includes welding plant, metal-spraying apparatus, hand tools and an Austin Seven engine driving a lathe and air compressor. Direct contact will be made with service stations and bus and truck operators' garage staffs. The expert demonstrators, besides giving advice, will seek suggestions that they can pass on to others during their travels.

In November the Government announced that it urgently required the loan for technical purposes (examination, not driving) of nine makes of any model, not earlier than 1937, of French, German and Italian cars, viz. Citroen, Peugeot, Renault, Opel, D.K.W., B.M.W., Fiat, Lancia and Mercedes. Precisely what these were needed for has not been divulged, but it was promised that the cars would not be retained more than three weeks and would be collected from and returned to their owners and fully insured while on loan.

A suggestion made in Parliament that the use of passenger trailers with buses should be authorized where the bus services were inadequate, or at rush hours, was turned down by the Minister of War Transport, who said that the difficulty of maneuvering such combinations at terminal points and elsewhere and the conditions under which bus services operated would make it unwise to adopt the course suggested.

Gasoline for certain military vehicles is now being distributed and carried in containers of specially treated cardboard. The object is not only to conserve metal, for it has been found that cardboard makes a safer container.

Instrument Gear Backlash -zero



This new Red Ring Rotary Shaving Machine shaves gears for range finders, sighting mechanisms and navigation instruments—gears with a ZERO BACKLASH and remarkably smooth tooth surfaces.

Also, it corrects errors of index, helical angle, tooth profile, and eccentricity. The entire operation takes only from 8 to 48 seconds per gear.

This is a vertical machine with full automatic control which offers full visibility of the work at all times and makes it extremely easy for the operator to load and unload without endangering either the work or the cutter.

If you are making instrument gears, write for the new bulletin on the GCL-3 Rotary Gear Shaving Machine.

NATIONAL BROACH AND MACHINE CO.
RED RING PRODUCTS
5600 ST. JEAN · DETROIT, MICH.

SPECIALISTS ON SPUR AND HELICAL INVOLUTE GEAR PRACTICE

ORIGINATORS OF ROTARY SHAVING AND ELLIPTOID TOOTH FORMS

International News Photo

Artificial Arctic Tests Tank Crews

Temperature in this test room, located at the Fort Knox, Ky., medical research laboratory, is 30 degrees below zero. Doctors continually check the reactions of the men as they work on the tank, thus gathering needed information on the ability of tank crews to withstand conditions on Arctic battlefields. Another test room is kept at 120 degrees to simulate jungle temperatures.

Hearings Scheduled On Labor Practices

The first of several public hearings and examinations of employment practices to be conducted by the President's Committee on Fair Employment Practice will be held at Detroit in February. The committee, which is the War Manpower Commission unit concerned with redressing grievances growing out of alleged discrimination against certain classes of war workers, particularly Negroes, will hold other meetings at St. Louis, Cleveland, Philadelphia, and Baltimore.

According to Lawrence W. Cramer, executive secretary of the group, the committee will investigate and check each of the complaints submitted to it through its field investigators, and will take up specific complaints, with the industries and labor unions involved, prior to the public hearing. If adjustments are worked out, Cramer indicated, there would be no necessity for public hearings on the questions at issue.

Dudley Heads Group On Plane Standards

Eric Dudley, of the Curtiss-Wright Corp., was elected national chairman of the National Aircraft Standards Committee at the fourth national meeting of the group, held at New York City. W. D. Craig, Jr., of the Grumman Aircraft Corp., was named Eastern Division chairman, with W. H. Colcord, of the Kellett Autogiro Corp., vice-chairman. G. T. Waite, of the Consolidated Aircraft Corp., was chosen Western Division chairman, with Charles Sardou, Jr., of Vultee Aircraft, Inc., vice-chairman.

The annual report presented at the meeting showed that 30 standards projects were completed during the preceding year and that 60 such projects are currently carried on the agenda.

MEN . . . . . .

C. A. Babbitt, of Norton Co., Worcester, Mass., has been appointed field engineer for the territory comprising New York City, New Jersey and Philadelphia, with headquarters at the Norton Philadelphia office.

Monsanto Chemical Co. has elected the following men to the board of directors: **Dr. Charles Allen Thomas,** Dayton, O. and **Ozborne Benzanson,** Woburn, Mass.

W. P. Hopkins has been appointed purchasing agent of the Tuthill Pump Co., Chicago.

George A. Lennox has been appointed general sales manager of the Driver-Harris Co., Harrison, N. J. He is succeeded as assistant sales manager by **Joseph B. Shelby,** who was formerly manager of the Foundry.

Raycroft Walsh, formerly vice-president, has been named senior vice-president of United Aircraft Corp. **J. Reed Miller,** general manager of the export division has been appointed a vice-president.

T. W. Merrill has been made president of The Advertising Corp., a newly organized general advertising agency with offices in the Midland Bldg., Chicago.

L. R. Howes, associated with the rubber industry since 1914, has been named sales engineer for the automotive and aeronautic departments of The B. F. Goodrich Co., with headquarters in Los Angeles.

Earl R. Billings has been appointed advertising and sales promotion manager of Pennsylvania Rubber Co., Jeanette, Pa.

Wilson H. Moriarty has been named assistant to the president of National Malleable & Steel Castings Co. and **Walton L. Woody** has become assistant to the president, in charge of the Sharon, Pa. and Melrose Park, Ill. steel castings plants.

Leo H. Rich has been appointed a member of the staff of Walter Dorwin Teague, industrial designer, for the development of a post-war planning program.

Felix Doran, Jr., general manager of the fleet division of General Motors Corp., has been appointed assistant chief of the tank and vehicle section of the Supply Branch, Tank-Automotive Center, at Detroit. He has been with General Motors since 1919, formerly serving as assistant general sales manager for Chevrolet. He will assist **Lieut.-Col. W. K. Ghormley,** chief of the tank and vehicle section, Supply Branch.

Two new co-chairmen, **Charles E. Wilson,** vice chairman of the War Production Board, representing the U. S., and **Harry J. Carmichael,** co-ordinator of production of Canada's Dept. of Munitions and Supply, have been appointed to the Joint War Production Committee of the U. S. and Canada. Wilson succeeds James S. Knowlson, also a vice chairman of WPB, who remains on the committee, Carmichael replaces G. W. Sheils, who retires from the committee.

William Reynolds has been named advertising and public relations manager of the Elastic Stop Nut Corp. He formerly was advertising manager of Servel, Inc.

L. B. Neumiller, president of Caterpillar Tractor Co., has been elected president of the Caterpillar Military Engine Co., Decatur, Ill., a Caterpillar subsidiary. He succeeds **B. C. Heacock,** who has joined the War Production Board in Washington.

Edward S. Evans, president of Evans Products Co., Detroit, has been elected a member of the board of directors of the Bowlus Sailplane Co., San Fernando, Cal.

Lester Watson, of Hayden, Stone & Co., Boston, has been elected a director of National Aviation Corp.

Don C. Streeter, formerly assistant general sales manager, has been appointed general sales manager of Reo Motors, Inc. He has been with Reo since 1926, serving as service manager for 22 years.

Richard H. Grant, vice president of General Motors Corp., has been named in charge of the sales committee to advise the Treasury Dept. on sales methods to employ in the government's war financing security program.

Orville Wright, inventor of the airplane, has been elected an honorary member of the British Institution of Mechanical Engineers in recognition of his contributions to mechanical science.

Salvage Aid Offered

Designed to assist industry on problems relating to salvage, conservation of materials, and the use of substitute metals for more critical ones, a new engineering service program has been established by the Metallizing Co. of America.

L. E. Kunkler, president of the company, stated in announcing the plan: "Our consulting service engineers are available to everyone engaged in war work, in addition to the regular service they are rendering present users of the metallizing process. By adopting this comprehensive engineering service plan, it is hoped that a speedy solution to each problem can be accomplished, thereby preventing further bottlenecks."

More power to you, Sailor!

Life or death in war is often decided by engine power. Sealed Power engineers and craftsmen work in constant recognition of this vital fact as they make piston rings, pistons and cylinder sleeves for marine, aviation and tank engines. Gas and oil are precious on the battle front. Sealed Power engine parts are designed to save fuel, yet deliver maximum power in bombers, fighters and pursuit planes, in jeeps, tanks, and Army trucks, in torpedo boats, destroyers and submarines.

Engine manufacturers, car and truck manufacturers, plane builders, boat builders, repairmen, fleet operators, Army and Navy officers are constantly consulting with Sealed Power Engineers on major engine problems.

SEALED POWER CORPORATION

Muskegon, Michigan • Windsor, Ontario

BUY MORE WAR BONDS

PISTON RINGS — PISTONS — CYLINDER SLEEVES

Girdler Says Maldistribution Of Steel Slows Material Output

Controlled Materials Plan Expected to Help in Relieving Unequal Distribution of Raw Material

By W. C. Hirsch

In so far as concerns the steel outlook, what Tom M. Girdler, chairman of the board of Republic Steel Corporation and also of that of Vultee Aircraft, Inc., had to say in an address at a recent meeting of the Chamber of Commerce of the State of New York, made it clear that in the opinion of representative steel producers and consumers, Mr. Girdler qualifying in both classifications, maldistribution of steel rather than inadequate production is the principal cause of slowing down war material output and that much of this shortcoming may be expected to be remedied by the new controlled Materials Plan of the War Production Board. In referring to "hoarders" as responsible for much of the dislocation, Mr. Girdler said he meant "those fellows who try to beat shortages by grabbing and hoarding, getting materials into the plant long before they are needed and just sitting on them." Such unnecessary anticipation of needs is rampane throughout the war materials fabricating industries and while free from the more sinister motive of hoarding: *profiteering*, dislocates just as seriously the delicate war time balance of production and requirements.

As for the Controlled Materials Plan, confidence in the helpfulness of which was emphasized by Mr. Girdler, the necessary preliminary work is well under way, and this has been erroneously interpreted in some quarters as denoting that it has already become fully operative, which is not the case. Dovetailing with Mr. Girdler's optimism regarding the supply of steel, if properly distributed, came reassuring words from Hiland G. Batcheller, director of the War Production Board's Steel Division, who in an address before the National Association of Manufacturers, forecast a rise to a record-breaking steel output of 8,250,000 tons a month, when additions to steel capacity now in course of construction have been completed. This would mean an annual production of 100,000,000 tons, twice what our output was when we went into World War I. Mr. Batcheller, who only recently found it necessary to warn against being unduly influenced by reports of "easier steel supply," said that "we can be reasonably more optimistic about a balanced supply in the future" of steel to war goods manufacturers. This, Mr. Batcheller said, would be accomplished in part through operation of the C.M.P. program, which becomes fully effective on July 1, 1943, and by further curtailment of the use of steel in non-essential civilian items. Many war material makers continue to experience difficulty in securing a promising place on the unfilled order books of alloy steel producers. The critical situation with reference to certain alloying metals has abated but little, and it is interesting to note that the American Iron & Steel Institute recently released a report, dealing with the beneficial properties of boron, calcium, titanium, zirconium, manganese and silicon in the hardening of lean alloy steels, thereby replacing vital quantities of the conventional alloying metals, such as chromium, molybdenum, etc. Non-metal alloying helps also find growing use in the "pepping-up" of medium and high carbon steels. While the immediate outlook for scrap supplies seems to have improved, with some steel mills turning down offerings of low grade material, mostly urban household scrap, the long range view, apprehending transportation difficulties, when real winter weather sets in, is none too cheerful.

The Aluminum Company of America has announced that pig aluminum as well as ingot is included in its price schedule. The basic price of pig aluminum is 14 cents per pound while the base price of ingots continues at 15 cents a pound.

Absenteeism Declining

(*Continued from page* 50)

pared to a six-day work week. The GM study showed that where men were engaged in a continuous automatic screw machine operation and assembly, the absenteeism in a section working seven days, 7½ hours per day, was double that in a section where a swing shift worked six days, 7½ hours per day. Physical and mental fatigue probably were responsible for this difference.

Canada's longest strike since the Dominion entered the war more than three years ago finally was settled Dec. 1 when more than 14,000 employees of the Ford Motor Co. of Canada at Windsor returned to their jobs after a week-long walkout. More than 75,000 man-days of labor on military vehicles and munitions were lost compared to 18,000 man-days for all of Canada since the war began. The walkout was precipitated by the hiring of 37 stockroom girls at a starting rate of 50 cents per hour. The UAW-CIO contended that the girls replaced men who had been receiving 75 cents per hour and charged that equal pay should be paid for equal work.

With Peter Heenan, Ontario minister of labor, serving as a mediator, an agreement finally was reached under which the strikers agreed to return to their jobs. This provided for the appointment of Justice Charles P. McTague, of the Ontario Supreme Court, as an umpire to decide which of the 37 women's stockroom jobs would be classified as production and which as office jobs. The company also agreed to hire only men at present for production work. Before the dispute was settled, 800 employes of four parts plants in Windsor supplying Ford were made idle when these plants were forced to close. It marked the first strike at Ford of Canada since the war began.

Other brief unauthorized strikes also marred the Detroit labor scene. Nine hundred employes at the Ecorse plant of the Murray Corp. of America staged a one-day strike in protest over failure of the War Labor Board to act upon a wage increase agreed upon Nov. 3 by the company and the union. Patterned after the GM wage decision, this provided a general 4-cent per hour increase and a 10-cent per hour raise for tool and die workers. It also equalized women's rates with those of men, but all wage raises are subject to approval by the WLB.

Four hundred workers at the Chrysler Kercheval plant were idle for five hours in protest over the firing of a welder who had been repeatedly disciplined for quitting early and for smoking on the job. The men returned to their jobs on orders from the UAW-CIO, which said the dismissal would be taken up under regular grievance procedure. Chrysler Corp. and the union have been negotiating for several weeks over a new contract, exclusive of wage rates. Six thousand employes of the Budd Wheel Co. walked out on one shift in protesting higher wage rates paid to new women workers compared to women previously hired. The next shift came on the job when state labor mediators held a conciliation meeting in an effort to bring a permanent settlement of grievances. Several disputes, most of them over wages and contract renewals, between automotive companies and the UAW-CIO have recently been certified to the WLB, which is overburdened with such controversies. The companies include Willys-Overland Motors, Inc., the Bohn Aluminum & Brass Corp., Detroit; Bower Roller Bearing Co., Bendix Aviation Corp., South Bend; and Morse Chain Division of Borg-Warner Corp., Detroit.

Briggs Mfg. Co. has signed a new contract with the UAW-CIO granting the same wage concessions as those approved for Chrysler Corp. by the WLB. These include a general 4-cent per hour raise for 15,000 employes and a vacation bonus of $45 for employes with one to five years' seniority and $90 for those with more than five years' seniority. Harrison Radiator Division of GM has signed a wage agreement with the UAW-CIO, retroactive to May 15, granting a 10-cent

Photo courtesy of Popular Photography

HOW MUCH MATERIAL CAN YOU *Save?*

Save Manpower, too

The National Safety Council is authority for the statement that 460 million man-days were lost through accidents in this country last year. That's enough time to supply an army of 200,000 with full fighting equipment. Remind your employees to play it safe *all the time*—on the job or away from it. Casualties on the home front are every bit as damaging as on the fighting fronts.

THE problem is simple to state. The nation's supply of essential materials must be made to go farther —particularly the vital alloy steels. More must be done with less.

Nosing out the scrap—the idle or dormant metal—is highly necessary, but it's only half the answer. The other half lies in using *new* alloy steels more efficiently—checking machine set-ups and plant procedures to reduce rejects, spoilage and undue scrap—using lower alloys wherever possible—plugging every loophole of waste.

Scrap the old steel, conserve the new; that's the only way the nation can secure a greater yield of war equipment for every ton of alloy materials taken off the national stockpiles. If we can help you save, through any printed or personal assistance, call on us.

Allegheny Ludlum
STEEL CORPORATION
GENERAL OFFICES: PITTSBURGH, PENNSYLVANIA

A-8678 . . . W & D

per hour wage increase and new basic rates ranging from 85 cents to $1.25 per hour. The UAW-CIO won an NLRB election at Harrison last April and threatened a strike in August, when the dispute was certified to the WLB.

A recent WLB directive has ordered Ford Motor Co. to grant a week's vacation or 40 hours' pay to employes with at least one and less than five years' seniority as of Nov. 30 and two weeks' vacation or 80 hours' pay to employes with five or more years' seniority. Under its dues checkoff agreement with the UAW-CIO, Ford has paid the union $2,030,678 in dues for the 16 months since the agreement went into effect in August, 1941. November payments totaled $143,371, the peak month to date.

Plans Completed For Giant Plane

(*Continued from page* 48)

of any plane so far produced. The "Mars" flying boat built by the Glenn L. Martin Co., is believed capable of transporting 150 armed troops, but its exact weight-carrying capacity has not been revealed. The ship has a wing span of 200 ft and, with load, weighs 70 tons. It is powered with four 2000-hp radial engines. Its cruising range is believed to be more than 6000 miles. The Army's B-19 bomber, the largest land plane built in this country, has a wing spread of 212 ft and weighs 82 tons fully loaded. Like the Mars, it is powered with four 2000-hp radial engines, and has a bomb-carrying capacity of eight tons. Its range is 7750 miles.

In his address to the New York Chamber, Girdler also revealed that American airplane production this year will exceed the total for the previous 20 years. He explained that changes are required constantly in new aircraft to meet varying conditions of weather and operation in the various theatres of war and said that no other nation has as varied requirements as the United States for its planes.

"Today," said Girdler, "30 prime contractors, operating 70 separate plants, are making 70 types of planes for war uses. Since June, 1940, approximately $50 billion has been appropriated for aircraft."

Despite the tremendous expansion of production facilities, he said, the aircraft industry is operating at barely 60 per cent of its capacity, because of the lack of materials. Besides, the industry has been harassed by a constant labor shortage.

"Today," he said, "the proportion of women in the industry on the West Coast approximates 35 per cent. Eventually at least 50 per cent of our employes may be women."

Girdler praised the controlled-materials plan, asserting that it would help to correct present shortages. He denied that a steel shortage exists, saying millions of tons of it are "lying around" in various plants. "I am firmly convinced that the new controlled-materials plan should be given a fair trial. It promises to uncork a lot of bottlenecks of production."

Marchev Is General Manager at Republic

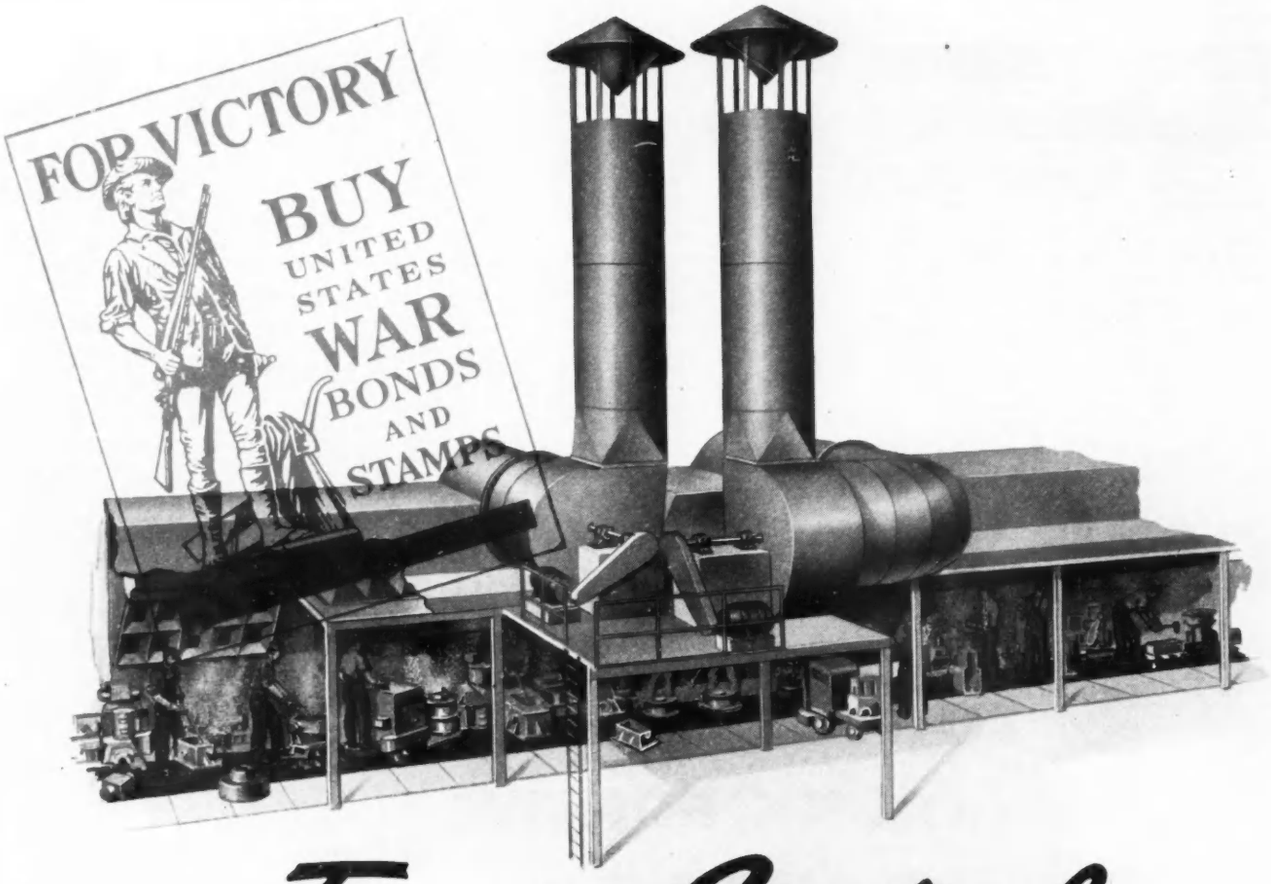
Ralph S. Damon, president, Republic Aviation Corporation, announced the appointment of Alfred Marchev, Republic Vice-President, as general manager of the Company's Farmingdale plant.

Marchev joined Republic Aviation in February, 1942, as assistant to the president, and later became vice-president and assistant general manager.

Damon relinquished the general manager's post to devote his full attention to supervision of the Company's plants here and in the Mid-West.

Prior to joining Republic, Marchev was chief engineer, works manager and director of the Signode Steel Strapping Company, of Chicago. Previously, he had been, for eight years, chief engineer and works manager for Ditto, Inc.

INGALLS-SHEPARD DIVISION
ARMY
E
NAVY
ARMY
E
NAVY
WORCESTER DIVISION
"To all who with heart, head and hand have contributed to this participation in the war program these Army-Navy production awards are proudly dedicated."—H. G. Stoddard, President.
WYMAN — GORDON
WORCESTER, MASSACHUSETTS • HARVEY, ILLINOIS



Fume Control

for aluminum and magnesium foundries

• The acrid, nauseating fumes and smoke resulting from knocking cores out of aluminum and magnesium castings can be collected and positively removed from the building with Bartlett-Snow Fume Control equipment. As illustrated in the cutaway view above, these systems consist of groups of Bartlett-Snow's highly efficient pyramidal shaped collecting orifices mounted along the backwall, (U. S. Pat. 124,704, July 30, 1940) and overhead in a canopy which extends out some distance beyond the knockout grating.

Castings to be knocked out are dumped on the grating from an industrial truck. The broken cores are dropped through the grating to a collecting hopper. The fumes and smoke, steam and dust are drawn off through the orifices and either exhausted directly to the outside atmosphere or passed through a dust collector, depending upon individual conditions. The men, since they rarely have occasion to step between the grating and the backwall, work in a cool clean air stream—seldom come into contact with even faint traces of smoke or fumes, have practically no restriction in their work.

Our recently completed 40-page Foundry Bulletin No. 91 illustrates many different types and applications of Bartlett-Snow foundry equipment,—contains much information of interest to every foundry owner and manager . . . Send for a copy today!

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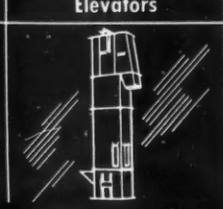
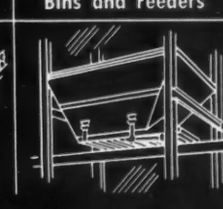
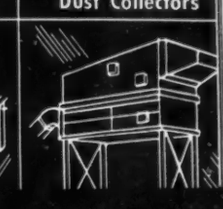
Complete Sand, Mold and Castings Handling Equipment for any requirement, including

Shakeouts	Elevators	Aerators	Sand Distributors	Bins and Feeders	Apron Conveyors	Dust Collectors
						

100% War Bond Buyers
Average Payroll Deduction 14%
H. S. Hersey
PRESIDENT

PUBLICATIONS

A revised catalog section containing simple, easy-to-read rules for **the care and maintenance of steam hose,** has been issued by The B. F. Goodrich Co. It contains also instructions on the proper method to attach couplings, and data on inside and outside diameter, weight and number of plies.*

A new illustrated manual on **Lucite for Aircraft** has been issued by E. I. du Pont de Nemours & Co. Methods of fabricating Lucite methyl methacrylate resin into airplane enclosures and other products are described in detail. Information on the care and handling, sawing, blanking, punching, drilling, etc., and for repairing Lucite are also given. Together with pictures and diagrams illustrating these various operations, the manual has a complete listing of the mechanical, thermal, optical, electrical and general properties of the plastic.*

A new catalog on the **Cincinnati 28" Series Vertical Hydro-Tel Milling Machine** has been issued by The Cincinnati Milling Machine Co. It is well illustrated with various views of the machine and a two-page photographic spread describes five operations on a single set-up. Included also are complete specifications and dimensional drawings.*

Experimental Tool & Die Co. has issued a new edition of the 4-page catalog describing the **Universal Slotmaster,** including illustrations and detailed information regarding six different set-ups of this machine.*

The Brown Instrument Co. has recently published a 64-page booklet, **The Technique of Precision Control in Industrial Processes,** prepared to acquaint engineers, operators and management with the manifold applications of Automatic Control to industrial processes. The text is divided into chapters which feature Precision Measurement, Fundamentals of Control, Types of Controls, etc. It contains also diagrams of basic control systems and illustrations of control apparatus.*

* Obtainable through editorial department, AUTOMOTIVE *and* AVIATION INDUSTRIES. Address: Chestnut and 56th Sts., Philadelphia. Please give date of issue in which literature was listed.

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TOGGLE CLAMPS FOR QUICK, POSITIVE CLAMPING IN ANY POSITION WITH

STANDARD HALF TURN

OR STRAIGHT CLAMPING BAR

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Ducommun Metals & Supply Company, Los Angeles; San Francisco

DANLY DIE SETS and DIE MAKERS' SUPPLIES

Business in Brief

Written by the Guaranty Trust Co., New York, Exclusively for AUTOMOTIVE AND AVIATION INDUSTRIES

Narrow fluctuations of general business activity continue. The seasonally adjusted index of *The New York Times* for the week ended Nov. 21 declined to 134.3 per cent of the estimated normal, as compared with 135.7 for the preceding week and 131.7 a year ago. The index of *The Journal of Commerce*, without seasonal adjustment, for the same period registered a recession of one fractional point to 129.1 per cent of the 1927-29 average.

Department store sales during the fourth week of November, as reported by the Federal Reserve Board, were 2 per cent below the comparable level last year, in contrast with a corresponding excess of 30 per cent shown for the week before. For four weeks, including all business days of the month except the last, the total was 14 per cent greater than a year ago.

Railway freight loadings during the week ended Nov. 28, reflecting holiday influence, dropped to 743,533 cars, 11.1 per cent less than the number for the preceding week and 14.2 per cent below that for the corresponding period last year.

Electric power output increased more than seasonally in the same period and was 12.8 per cent greater than a year ago, as against a similar excess of 16.9 per cent a week earlier.

Crude oil production during the fourth week of November averaged 3,878,000 barrels daily, 34,400 barrels below the figure for the preceding week and 153,400 barrels less than the average output recommended by the Office of the Petroleum Coördinator.

Average daily production of bituminous coal during the third week of November was 1,918,000 tons, as compared with 1,850,000 tons in the week before and 1,564,000 tons a year ago.

Engineering construction contracts awarded in the week ended Dec. 3, again exceeding $100,000,000, amounted to 10 per cent more than the comparable figure last year, according to *Engineering News-Record*. For 1942 to date, the total is 59 per cent greater than the corresponding amount in 1941—with public work advancing 86 per cent, as against a drop of 52 per cent in private contracts.

Professor Fisher's index of wholesale commodity prices for the week ended Nov. 27 remained for the third consecutive weekly period at 108.5 per cent of the 1926 average, as against 99.0 a year ago.

Member bank reserves rose $94,000,000 during the week ended Dec. 2, but estimated excess reserves declined $20,000,000 to a total of $2,500,000,000. Business loans of reporting members fell $48,000,000 in the preceding week and stood $361,000,000 below the total a year earlier.

A.C. Arc Welder

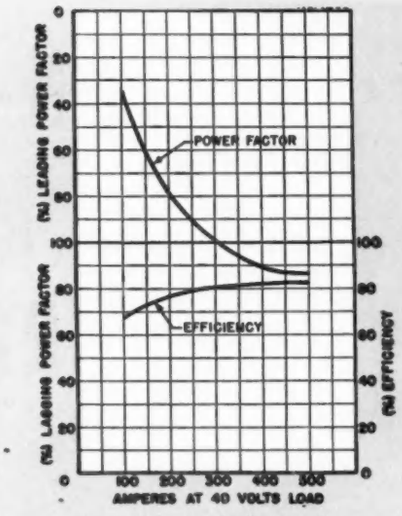
the WILSON "BUMBLE BEE" for greater speed of welding

300, 500, 750, 1000 AMPERE CAPACITY WITH 42 VOLT OPEN CIRCUIT VOLTAGE

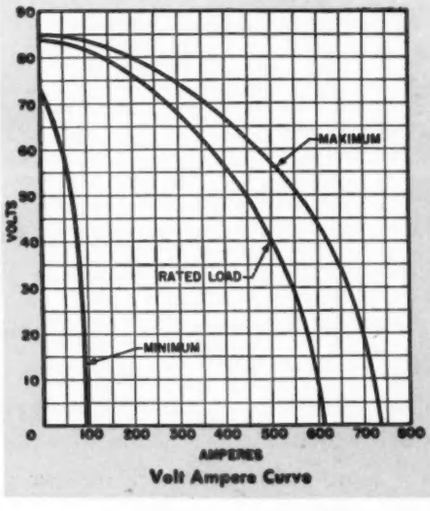
Utilizing an altogether new principle developed by the Wilson Engineering Department, this new series of A. C. Arc Welding machines has the following outstanding advantages:

1. Low open circuit of 42 volts which is lower than any other available machine.
2. Wide current range well outside of NEMA range and rating.
3. Power factor correction with built-in capacitors at no extra cost. This results in a power factor ranging from 100% to 86% lagging over the popular working range.
4. Improved electrical efficiency from 80% to 82% over the working range.
5. Simplicity of control. Infinite steps of adjustment throughout NEMA range with only one hand wheel control.

Other important features of the new Wilson "Bumble Bees" are dual voltage connections for quick change from 220 to 440 volt or vice versa, and a thermal overload protection device which cuts out overload current only after the temperature of the windings reaches a dangerous point. This new Wilson development eliminates unnecessary interruptions, yet provides complete protection against overheating. Streamlined, simple to control and operate, Wilson "Bumble Bees" represent an important advancement in A. C. welding.



Power Factor and Efficiency Curve



Volt Ampere Curve

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WASHED COAT ELECTRODE AVAILABLE ON LOW PRIORITIES

Wilson No. 18 Washed Coat electrode is an all-purpose electrode for general welding on low carbon and mild steel. It is made in 5 sizes — 3/32", 1/8", 5/32", 3/16" and 1/4", with a tensile strength of 45,000 to 60,000 p.s.i. as welded, and elongation in 2" of 7% to 10%. The surface coating materially improves arc stability and operating characteristics over those of bare electrodes.

WILSON

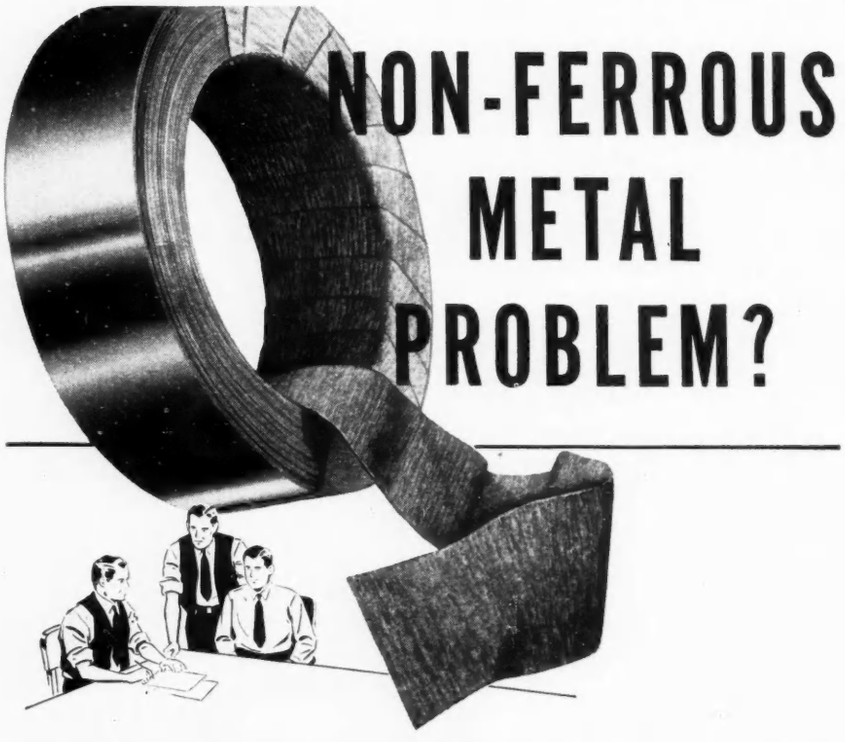
Applications of the Electric Strain Gage

(*Continued from page* 42)

area, and—last but not least—it will lessen the need for overlapping assumptions when the time comes for the design of a similar plane.

As mentioned previously, both the strain gage and the accelerometer pick-ups are suitable for vibration-recording work. In flight tests, any strain-recording channel records all stress variations due to oscillations of the aircraft structure. That feature sometimes is taken advantage of to determine the nature and the seriousness of such oscillations. Fig. 6 is a section of the oscillograph record of the mild oscillation of an airplane tail. The tail was excited at the proper frequency on the ground, and the record reproduced in Fig. 6 was made. It was obvious that on the ground the oscillations were of much greater amplitude than in flight; nevertheless the stresses produced were measured and were found to be negligible. An identical record was then made with the plane in flight while similar oscillations were occurring, and it was possible to demonstrate that the oscillations in flight were much less serious.

Certain technical difficulties are met with in the application of the equipment being dealt with. For instance, low stresses may be indicated if there is a lag due to imperfect cementing of the gage to the surface investigated. Yield of the wire of the gage itself at higher stresses may cause difficulties, and troubles common to involved electrical circuits may be encountered. Such problems, however, are associated more closely with the development of the equipment than with its application. Aside from technical difficulties with the equipment there are endless human problems involved in any large-scale application of same. Preparation for the rapid, accurate and permanent recording of pertinent data is necessary, and organization must be provided to assure rapid reduction of the data once they are recorded.



INVESTIGATE THOMAS ELECTRO-COATED COLD ROLLED STRIP STEEL . . .

● Thomas provides dense, non-porous, crackproof, and peelproof electro-coated finishes. Since these finishes are applied to steel which meets specifications accurately, many manufacturers of war parts find electro-coated Thomastrip adaptable to jobs which formerly used solid non-ferrous metal. The coatings lend themselves readily to forming and drawing operations.

SPECIALIZED PRODUCERS OF COLD ROLLED STRIP STEEL

THE THOMAS STEEL CO.
WARREN, OHIO

BRIGHT FINISH NOT COATED, SOLDER COATED, ELECTRO-COATED WITH NICKEL, ZINC, COPPER, BRASS

Send for useful cold rolled strip steel book, illustrated above.

Phenolic Resin for Dies

ANNOUNCEMENT of a phenolic casting resin for metal forming dies, jigs, fixtures, etc., called Durez 7421 Liquid Resin, was recently made by Duez Plastics & Chemicals, Inc., North Tonawanda, New York. The maker states that this resin can be readily cast at room temperatures through the use of an accelerator. The cast product is said to have the following properties: compressive strength, 15,000 to 20,000 Psi; impact strength, 0.11 to 0.15 Izod; flexural strength, 7000 to 9000 Psi; modulus of elasticity, 0.5 x 10.6. Durez 7421 Liquid Resin is a thermosetting material which sets by baking at temperatures above 100 degrees C. By using an accelerator, castings can be made at lower temperatures. Baking two to four hours at 140 degrees F. is standard procedure. Nomal shrinkage is said to be only .003, in lacquered wooden molds, after baking two hours.

Resin Powder from Pine Trees

Plastic compositions which can replace steel or other metals in many uses may now be manufactured by incorporating with various cellulosic fibers a resin powder known as Vinsol, extracted by chemists of the Hercules Powder Company, Wilmington, Del., from the Southern pine tree, according to an announcement by The Patent and Licensing Corporation, New York, N. Y. This structural resin plastic is an addition to the family of resin-treated laminated paper products. It is a thermoplastic, fibrous resin composition, hard, dense, stiff, but with reasonable toughness.

Curing of the raw stock requires hydraulic steam presses which operate at 275-350 deg F, at 800-1500 psi, and which have rapid cooling means. Special compositions may be supplied which will permit curing at 300 psi. The curing cycle is from 4 to 6 min. The Vinsol resin is available without priorities.

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"Plexiglas"

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WITHOUT injecting sales talk, the Rohm & Haas Company has produced a sound film on the maintenance and repair of PLEXIGLAS.

It's a factual, semi-technical film designed to facilitate the use of PLEXIGLAS in war production. It already has been shown in more than 150 Army Air Force bases as an aid to ground crew instruction.

The opportunity is offered to the aircraft industry and to educational institutions to borrow a print of this interesting 16 mm. sound film. Using your letterhead, write Rohm & Haas Company, Washington Square, Philadelphia, Pa., giving your first and second choice of dates and the approximate length of time you expect to use it.

FABRICATION

MAINTENANCE

REPAIR

PLEXIGLAS *is a trade-mark, Reg. U. S. Pat. Off., for an acrylic resin thermoplastic manufactured by the Rohm & Haas Company.*

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Manufacturers of Leather and Textile Specialties and Finishes.. Enzymes.. Crystal-Clear Acrylic Plastics.. Synthetic Insecticides.. Fungicides.. and other Industrial Chemicals

Air vs. Rail and Water Transport

(*Continued from page* 19)

terms of value is machinery. Typical of this group would be 1/3-hp. electric motors, which have an export value of about 30 cents a pound. From the comparative cost figures that we have just developed it can be computed that the rail transportation cost of these motors from Chicago to San Francisco would be 8/10ths of a cent per pound, and the shipping cost by surface vessel from San Francisco to Brisbane, Australia, ½ cent per pound. The total cost of transportation from Chicago to Australia, amounting to 1 1/3 cents a pound, is equivalent to 4 per cent of the value of the motor. That is the transportation cost by surface means. If shipped by air, the cost from Chicago to San Francisco would be 31 cents per pound (slightly in excess of the value of the motor), and from San Francisco to Brisbane $1.28 per pound. The total is $1.59—over five times the per-pound value of the motor. This high transportation cost might be well justified if some plant in Australia were shut down due to motor failure and no replacements were available locally. By use of the airplane the plant could be operating again in four days, whereas if the replacement motor were shipped by surface means, four weeks would elapse before the situation could be remedied. Under such circumstances such a high tariff would no doubt be justified, but for the large quantities of motors needed to meet normal demand, the high cost of transportation by air would be hard to justify.

On the return trip a typical commodity imported from Australia is raw wool, also having a value of about 30 cents per pound of shipping weight and therefore would give us the same effect on the cost of such wool laid down in San Francisco. Among our 1940 imports from Australia there is listed 558 ounces of platinum valued at $26,000, equivalent to a value of $560 a pound. Here the cost of air transportation would amount to 3/10ths of 1 per cent of the value of the commodity—a ratio making such shipments entirely practical. Unfortunately, there were only 558 ounces to be shipped.

Admittedly, the examples are based on present-day costs which are without question high because our business is relatively new and we haven't yet had the opportunity to take advantage of all possible economies. There is still much uncertainty as to the cost of operating the giant airliners projected for the future. Most studies we have seen treat direct flying costs in considerable detailed accuracy and then slap on overhead on the basis of a fixed percentage. This is the procedure usually followed by those who have not had the opportunity of actually being engaged in airline operation. Very little attention has been given to the evaluation of terminal costs, and pickup and delivery of merchandise either side of the terminals. Surface carriers have found that their terminal costs are at least equal to and often greater than their over-the-line costs.

Little thought has been given to the fluctuation of traffic within the day, from season to season, or to the unbalance in directional traffic flow, or to the short-haul nature of the greater part of all traffic. All these things tend to set limits on utilization and load factors which no one other than those engaged in the business can determine.

Our Engineering Research Department has tabulated the possible reductions in direct flying costs that might result from a full realization of all the technical advances that are now in the development stage. Included are such possibilities as:

1. Design of the aircraft to suit the job which it must perform.
2. Higher lift and lower drag characteristics.
3. Advances in structural design and materials, allowing major increases in useful load capacity

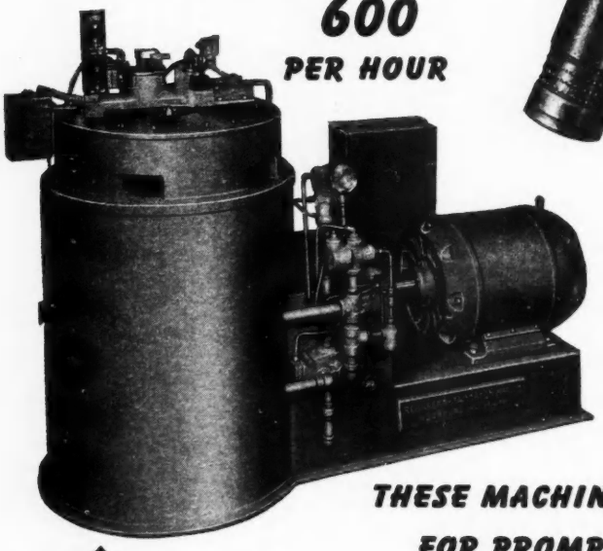
High Speed Automatic
SHELL-BANDING MACHINE

FOR 20 MM. TO 75 MM. A. P. OR H. E. SHELLS

Operator drops shell and band into the "nest", presses a button, the machine squeezes the band in place and ejects automatically. One, two, three, or four squeezes can be selected, with automatic indexing between squeezes to permit uniform metal flow, prevent crystallization of the copper, and provide thorough penetration into the serrations. First stroke, when two or more are used, is a partial squeeze to flow the ring to top of serrations. Pressure can be closely regulated to suit a variety of conditions. Production obtainable depends on the efficiency of the operator in loading. Cycle of one stroke is 1½ secs.

CAPACITY - 37 MM. SHELLS
600
PER HOUR

20 MM.
SHELLS
1200
PER HOUR



The R-J Shell-Banding machine is hydraulically operated with electric controls. It will handle all sizes of projectiles from 20 mm. to and including 75 mm. size, either armor-piercing or high-explosive types. It can be changed over from one size to another in less than 15 minutes. Equipped with a 10 h.p. motor and takes floor space of 36" x 72".

THESE MACHINES AVAILABLE
FOR PROMPT DELIVERY

REHNBERG R-J JACOBSON

REHNBERG-JACOBSON MFG. CO.
Special Machinery
2137 KISHWAUKEE ST. • ROCKFORD, ILLINOIS

What are you doing with that EIGHTH DAY?

We all have time to do Imagineering even though we're working seven days a week to win the war.

Making the start on deciding where your business is going to head after this thing is over doesn't require stockholders' meetings, nor even board meetings, nor even committee meetings.

Best way to make your beginning is to look at the future in the large. The war will end. So will this production race on war materiel. Millions now employed at that kind of work will need to keep on working at *something* useful. Other millions will come home from wherever, needing useful and peaceful employment.

In the large, therefore, anyone can see that *new things to make* is a prime need for peacetime.

That makes everyone's individual responsibility clear and direct.

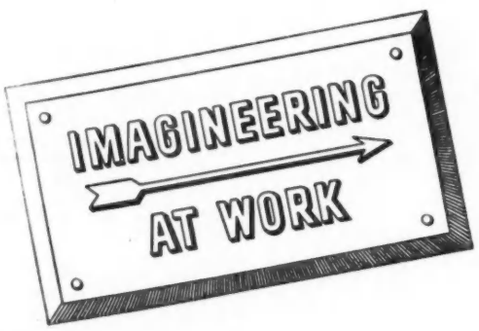
In the eighth day of thinking time everyone has at his disposal, he must produce new ideas for new jobs. He *must* let his imagination soar and engineer it down to earth.

He must, or else—

We believe this deeply at Alcoa. We are using our eighth days that way. We mean that no man shall be out of a job when this thing is over for want of *try* on our part right now.

And if you suspect that some of the results of our future-looking on aluminum would fit into your own Imagineering, let's compare notes for future reference.

ALUMINUM COMPANY OF AMERICA, 2110 Gulf Building, Pittsburgh, Pennsylvania.



ALCOA ALUMINUM

4. Power plant improvements such as lowered fuel consumption, partial set propulsion.
5. Improvements in terminal and aircraft loading and unloading facilities.
6. Improved airports — layout and size.

All of these things taken together might direct flying costs as much as 60 per cent, but taking overhead costs into consideration total costs would probably be lessened only by about 35 per cent. This would be at current traffic volumes. The effects of increased volume in reducing costs is well known in all lines of business. In the air transport industry based on the record of its performance to date, and assuming that the law of diminishing returns will not begin to exert its tempering influence, we might logically assume that a hundredfold increase in all traffc volume from today's levels would result in a further reduction of 60 per cent in total unit costs. Therefore, the combined effect of all the presently contemplated engineering advances plus a hundredfold increase in volume might be expected to reduce overall ton-mile costs from their present average of around 40 cents to levels somewhere in the neighborhood of 10 cents per ton mile, still many times the cost of surface transportation which measures its ton-mile costs in mills. We must also bear in mind that while the air transport business is reducing its costs the railroads and the steamship companies will be doing the same.

In the field of passenger travel, the airplane may well take over a major share of the volume. Passengers as a commodity have a high value per pound and per hour and require a relatively large amount of cubic space. These factors combine to make the costs of transporting passengers by surface means and by air somewhat more comparable than is the case with other cargoes. Individuals are also influenced by consideration of convenience, comfort and such other intangibles as the romance and prestige associated with travel by air.

But an inanimate piece of cargo presents a different problem. Here values per pound bear a much lower relationship to transportation costs. The time saved must be business time, and it must be strictly worth the saving, and weight can be concentrated in a much smaller space. We have already suggested some of the conditions that must exist in order to justify shipment of freight by air:

1. An emergency has to be met.
2. An opportunity must exist for a substantial saving in warehousing and inventory costs.
3. Commodities must have a value per pound sufficiently high to make possible worthwhile savings in financial and insurance costs.
4. Surface transport must be inadequate or nonexistent.

● To win our share of this war we've got to tighten up—toughen up. We've got to funnel the work of three hours into one. Today production finishing requirements become more and more critical. The demand for speed and more speed becomes more insistent. That's why it is imperative to leave no stone unturned to find the finishing materials and methods that will push your production up to the peak you have to hit and keep it there.

It will pay you to learn why McAleer metal finishing materials and methods are performing such outstanding service for the leaders in your industry today—and, more important, how similar materials and methods can solve your metal finishing problems.

McAleer will work with you—recommend "tailored-to-fit-the-job" materials and methods—and then follow through as needed. The value of this service is already written in the finishing production records of many manufacturers who are working today under greater pressure than ever before. McAleer's Finishing Engineers and laboratory staff have helped them bust some pretty tough production bottlenecks . . . and usually with a plus of increased production, better finish and lower operating costs. It's the kind of a job we want to do for you.

McALEER

McALEER MANUFACTURING CO. • ROCHESTER, MICHIGAN

Alternates for Varnished-Silk

VARNISHED rayon, varnished cotton cloth and varnished Nylon have been developed by the Irvington Varnish & Insulator Company, Irvington, N. J., for electrical insulation formerly provided by varnished silk. All these materials possess good dielectric strength, with tensile and tear strengths equal to or better than those of varnished silk, and can be punched into special shapes. They are available in thicknesses from 0.003 to 0.008 in. in straight-cut rolls or bias-cut strips 51 in. long. Each base material is coated with Irvington insulating varnish.

High-tenacity varnished rayon is said to be the most suitable alternate for varnished silk, comparing favorably with it in strength and flexibility. It has a dielectric strength of 1200 VPM and is used for wrapping leads, small magnetos and coils. Varnished cotton cloth has greater tensile strength than varnished silk. Its pliability permits application to odd shapes. Its dielectric strength is 1200 VPM. Varnished Nylon has qualities of flexibility and high tensile strength, with a dielectric strength of 1200 VPM. At present Nylon is available only upon Government allocation.

Pearl Harbor

this LAKE ERIE WAR PRODUCTION BOARD WENT INTO ACTION

The fact that this would be a War of Production was recognized by Lake Erie years before Pearl Harbor. It was then that LAKE ERIE established its own War Production Board. Key men of Lake Erie Management, Sales, Engineering, Purchasing, and Production were given the go ahead on the basis of all-out war effort.

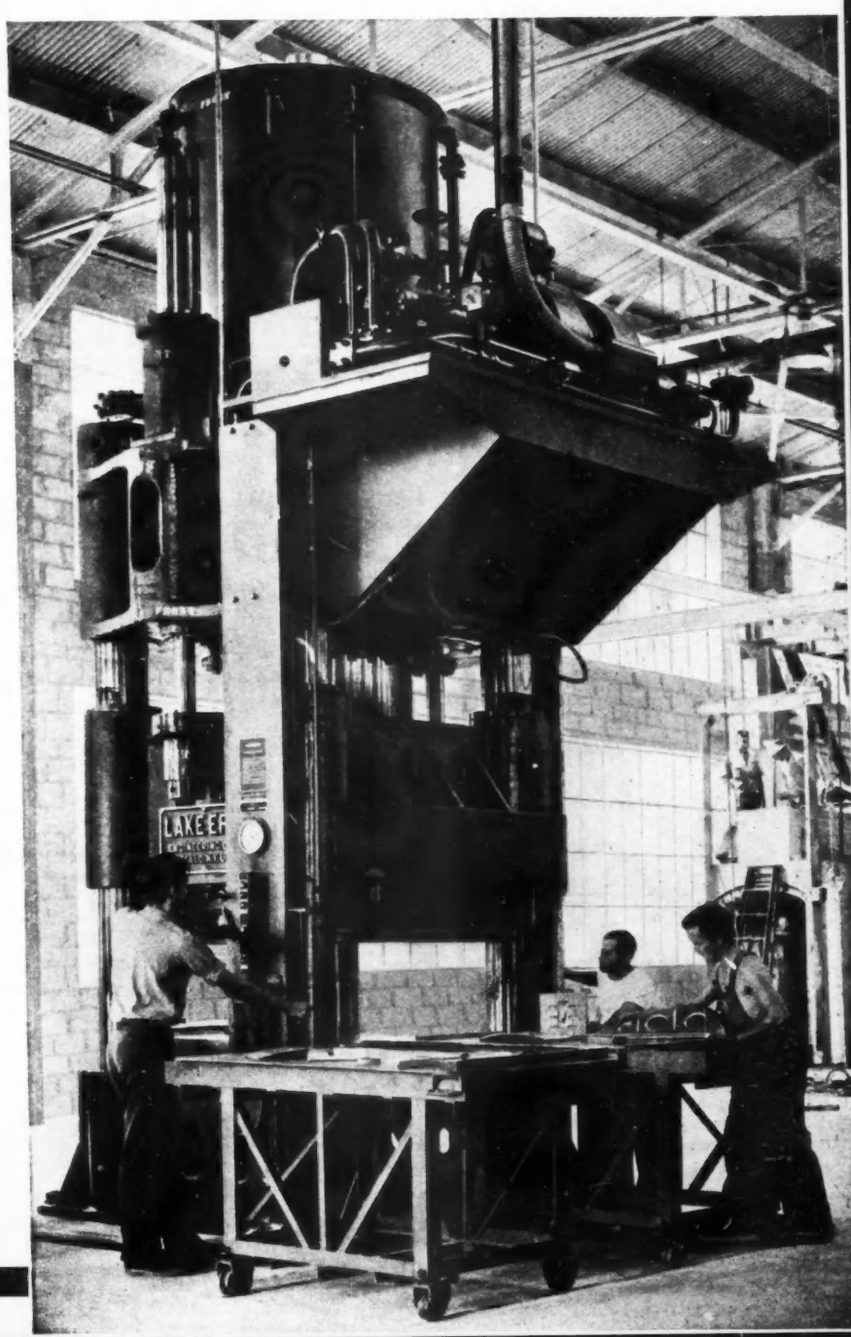
Every department was synchronized to build Lake Erie Hydraulic Presses . . . to build them well . . . to build them FAST!

STANDARDIZED DESIGN

Engineering was standardized, patterns were standardized, manufacturing was standardized . . . out of Standardization came Simplification . . . out of Simplification came INCREASED PRODUCTION!

The complete line of Lake Erie Hydraulic Presses includes single, double and triple action types up to 23,000 tons capacity. Standardized models are ready for blanking, forming, drawing, coining, bending, straightening, extruding and practically every other pressing operation having to do with aircraft, ordnance, ship building, plastics and other war material.

Every member of the Lake Erie War Production Board is at your service from inquiry . . . to delivery . . . to installation!



Showing one of the many Lake Erie Hydraulic Presses which are speeding up the output of fighting equipment.

Propellers in the Making

(*Continued from page* 25)

diamond-tipped fly-cutters. Following this series of operations, the blade is subjected to final horizontal balance, weighing, Government visual inspection, and is delivered to the paint shop. Here it is degreased, given one coat of primer in a Binks spray booth, and the paint dried in an infra-red lamp baking oven. The blade then is masked, sprayed with black lacquer, dried in the infra-red lamp cabinet, inspected and balanced again. It is important to note that balance is so sensitive as to be affected even by the coating of paint.

The spider comes in as a rough forging, inspected for seams and cracks, and for Brinell hardness. Initial machining operations are performed in two separate stages on 16 in., 6-spindle, Bullard type D Mult-Au-Matics. Arm ends are rough milled on Milwaukee mills, then the bore is rough-broached for 15 spines on a 4L LaPointe vertical broaching machine. End bores are ground on 72A-5 Heald plain internal grinders. This is followed by rough- and semi- and finish-turning of the arms on Bullard 8-spindle Mult-Au-Matics.

A series of slots between the arms are cut on a 5-54 Cincinnati Hydro-Broach, taking one slot at a time. Various milling operations on the flanges and bearing diameters are handled in separate settings on Sundstrand Planetary Rigidmils and Automatic Stub lathes. Landis, Norton, and Cincinnati plain grinders are employed for various rough- and semi-finish grinding operations. This is followed by blending operations with a Kellerflex, and finish-grinding on angular-head Landis machines and Cincinnati plain grinders.

Internal grinding operations are handled on Heald internal grinders, polishing of the arms on Schraner lapping machines. Final inspection is on the big Electrolimit gage mentioned earlier. Then the spider is cadmium-plated.

The barrel assembly is made up of two separate forgings, machined individually, then finish-machined as an assembly in matched pairs. After preliminary rough inspection, the parting face of each half is ground on a Hanchett or Blanchard rotary surface grinder fitted with a magnetic chuck. All of the holes are drilled and reamed on a Natco multiple spindle drill press. Tops of bolt lugs are milled in a Sundstrand Rigidmil. The remaining operations of boring, facing, and turning are completed in one setting on a 16 in., 8-spindle Type D Bullard Mult-Au-Matic. The internal diameter is ground on a 16-28 Bryant Hydraulic hole and face grinder.

The barrel halves—front and rear—now are matched in pairs, bolted together and stamped and ready for the cycle of final machining as an assembly. First operation on the assembly is the boring and facing on a double-index, 16 in., 6-spindle Bullard Mult-Au-Matic. The sections around the bolt bosses and the arm ends are broached on a LaPointe surface broaching machine. Next follow form-milling, contour-grinding and polishing and blending operations. Then the parting face and hub are finish-ground on a Blanchard surface grinder fitted with a magnetic chuck. Internal bore and faces are finished on Bryant internal grinders.

Gasket grooves, which hold the key to oil-tightness of the assembly, are profiled on a four-spindle Cincinnati Hydro-Tel. Acme threads are milled to gage on a Lees Bradner thread miller, holding concentricity over three locating pins with a tolerance of plus or minus 0.002 in. full indicator reading. Rough- and finish-boring and recessing of the front half is done on 5D Potter & Johnston turret lathes. This bore is finish-ground on a Heald plain internal grinder. Various holes are drilled and rough-tapped, then finish-tapped by hand.

Major machining is followed by detail hand grinding, polishing, and blending operations with Kellerflex tools, then polishing and balancing of

A complete Bearing Service for the

PRODUCTION FRONT

Idle machinery will not win the war. Most delays, caused by bearing failure, can be avoided. Down time *can* be cut to a minimum. Here's how —

Institute a regular method of inspection . . . once a day for machinery in constant use . . . at least once a week for all others. Make sure the bearings are kept clean, well lubricated and properly aligned.

When failure is inevitable, order replacement bearings *in advance*. Call in your local Johnson Distributor. From our list of stock items . . . over 850 sizes of General Purpose Bronze Bearings, 250 types of Electric Motor Bearings, 350 sizes of Johnson UNIVERSAL Bronze Bars . . . he can show you how to secure your needs with a minimum of delay. He is listed in the classified section of your telephone book . . . under BRONZE. Keep every machine going on the Production Front.

• *Write for* FREE *Catalogue* •

JOHNSON BRONZE

Sleeve BEARING HEADQUARTERS

625 S. MILL STREET · NEW CASTLE, PA.

It took FIFTEEN YEARS to build our World Routes, now so vital to Victory

Every American knows the story of Lewis and Clark—the men who pioneered a trail across the North American continent to the Pacific.

But few Americans know the story of how Pan American Airways—our Merchant Marine of the Air—pioneered skyways across two oceans and down the length of South America in the short space of fifteen years.

In Central and South America, cloud-piercing mountains, hundred-mile swamps and deadly jungles blocked the path. For much of the territory, no accurate maps existed . . . None had been made since the 17th-century charts of the Spanish, Dutch and French explorers.

To equip some of our early airports on the route to the Panama Canal, gasoline had to be carried in *by hand*—long lines of natives, each with a five-gallon tin balanced on his head.

In the Pacific, at Midway and Wake Islands, there were no harbors . . . Construction materials had to be towed through heavy seas, floated over barrier reefs and landed on the beach despite the heavy breakers.

Across Africa also, airports had to be hacked out of jungles and built up on desert wastes. At some points the only available hauling power was furnished by camels . . . Native Africans who had never seen an airplane were employed as artisans.

In Alaska, summer is brief—roads did not exist. Airports had to be built on unfriendly swamp morass or, when it was available, on glacial gravel and sand.

* * *

Today all these routes are playing their part in hastening Victory for the United Nations.

Without exaggeration, it can be said that the existence of facilities pioneered by Pan American has saved the United Nations' aerial war transport many long months.

Wings over the WORLD

PAN AMERICAN CLIPPERS

each half separately. Finally the halves are subjected to a Magnaflux inspection for surface perfection and inspected dimensionally. These operations are completed by finish-polishing for plating, cadmium-plating, and final inspection of the plating and threads.

Outstanding character of the Nash-Kelvinator operation is that this plant produces actually all of the major elements and most of the detail parts that go to make up a complete automatic propeller assembly. In addition to the major parts mentioned briefly above, they make all of the gears, gear segments, stationary and rotating cams, pistons, dome, fastenings, etc. It is, in effect, one of the most self-contained propeller operations to be found in this field.

Owing to the wide use of bevel gearing, the bulk of the gear cutting equipment is of the familiar Gleason type, employing the latest Revacycle roughing machine, and the Gleason two-blade generators for finishing. On the stationary cam, Fellows gear shapers are used for cutting an internal gear containing 288 serrations.

Barnes Drill Co., honing machines, fitted with Micromatic hones are used for finish-honing the bore of the piston assembly.

Generally speaking, cemented-carbide tools are employed principally for the turning, boring, and facing of nonferrous parts such as the aluminum dome which is received as a large stamping. This is turned, faced, and form-domed on a battery of Potter & Johnston 5D automatic turret lathes, using cemented-carbide-tipped tools. Both cemented-carbide and diamond-tipped tools are used on the many Heald precision-boring machines. Industrial diamonds are employed generously in dressing tools on the many internal and external grinders and on the precision thread grinders.

Good housekeeping, so essential to the maintenance of exceptional quality control, is well in evidence throughout the plant. This is an important corollary in the operation that started out properly with good fresh paint treatment and new production equipment.

In retrospect, it may be noted that the best evidence of modernity in this plant is found in the adoption of surface broaching to speed up operations that might normally be done by milling; in the adoption of special purpose equipment wherever necessary; in the development of a well-coordinated materials handling system so essential to the maintenance of a balanced flow of materials to and from the machines.

To supplement the brief word picture given above, we have reproduced a carefully selected group of illustrations, providing our readers with a perspective of various phases of the operation.

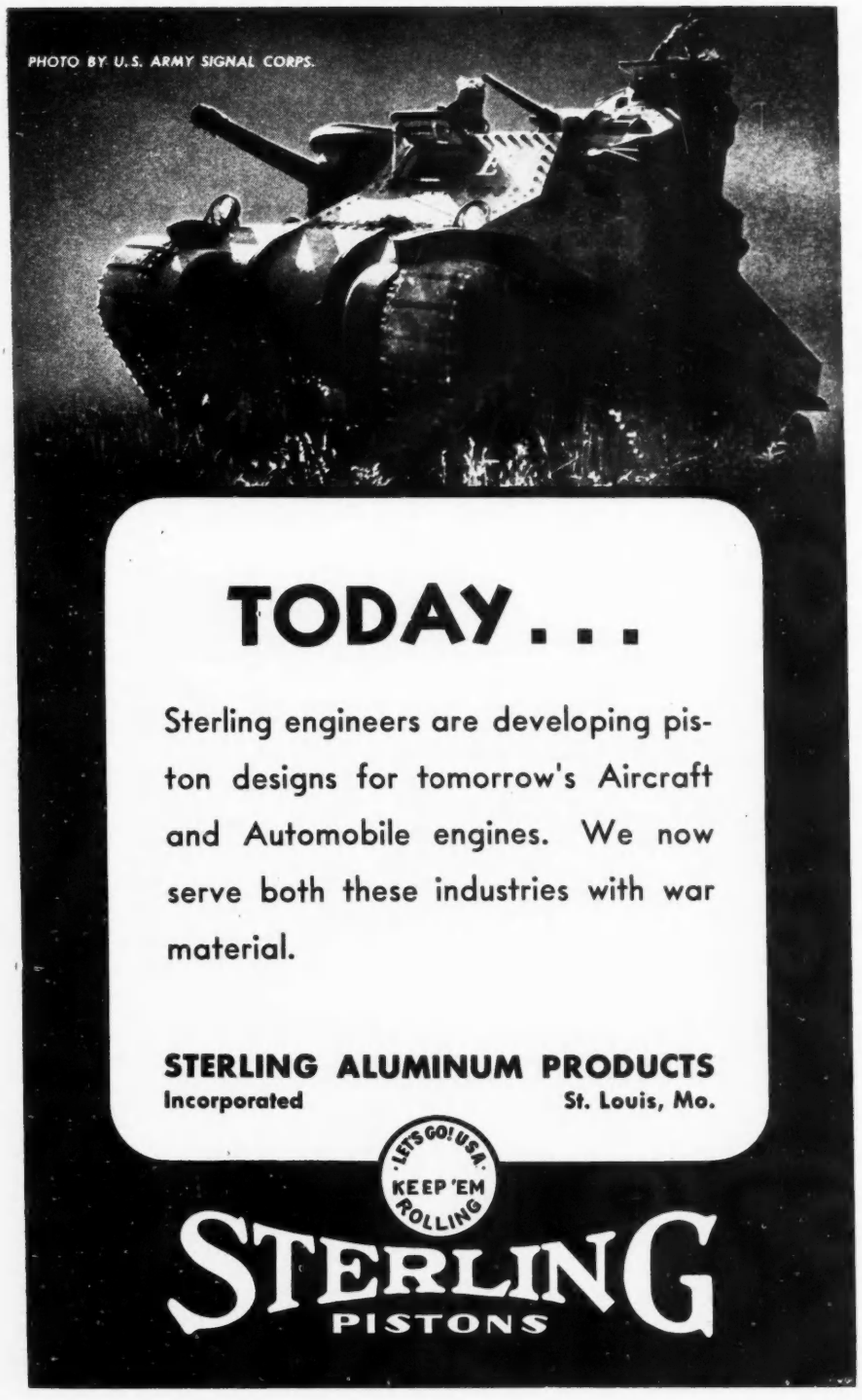
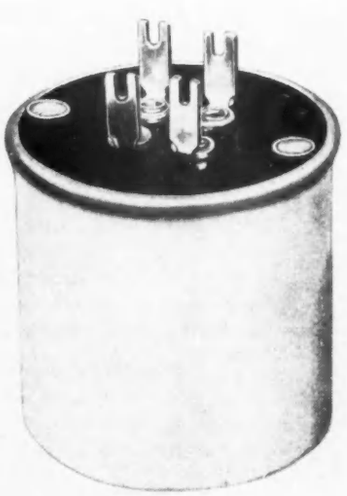
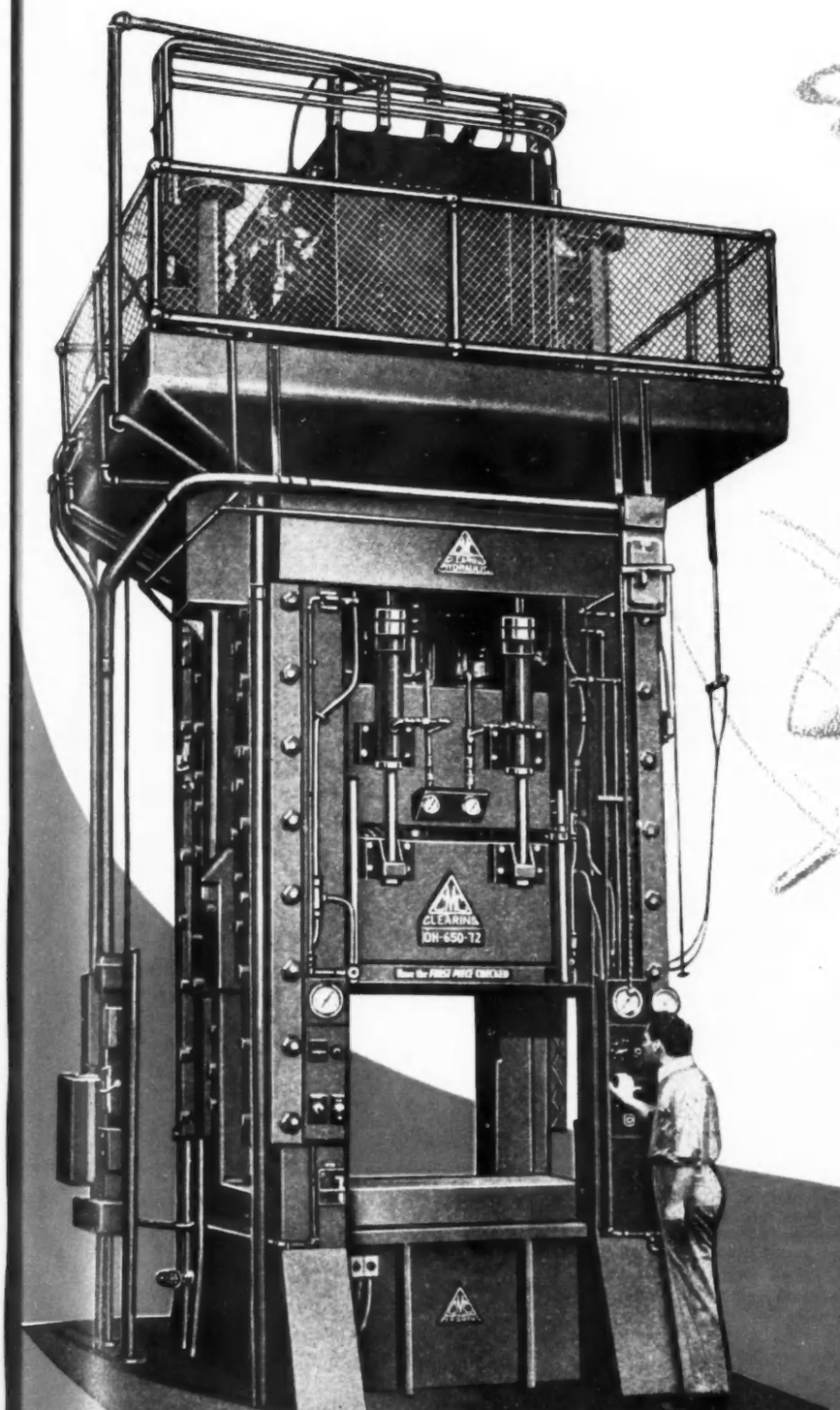


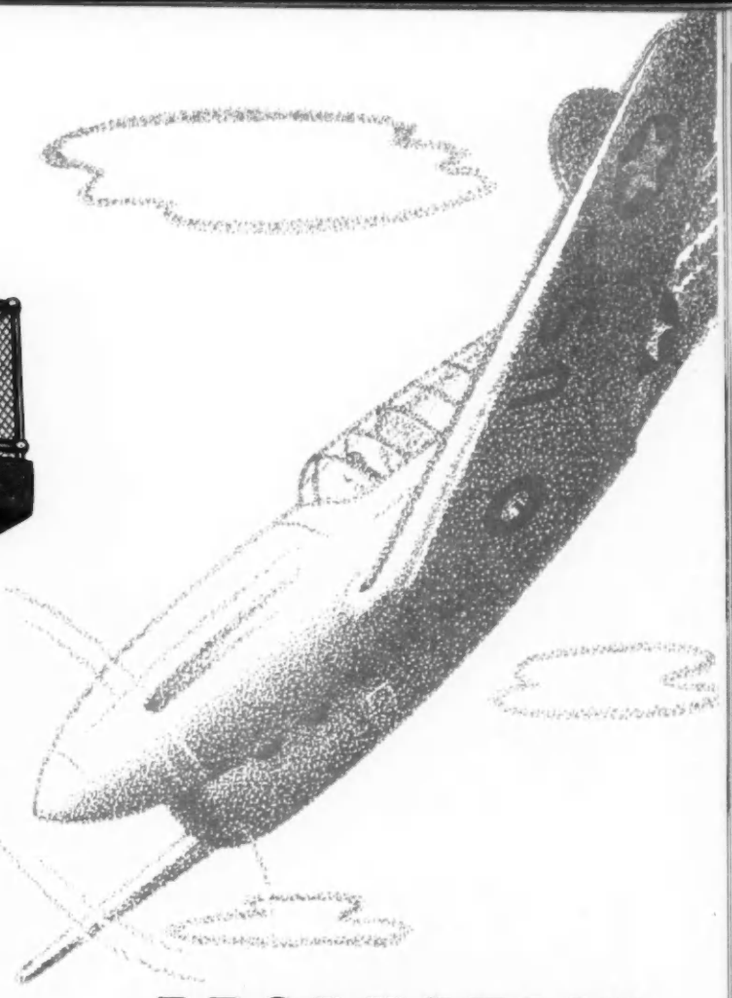
PHOTO BY U.S. ARMY SIGNAL CORPS.
TODAY . . .
Sterling engineers are developing piston designs for tomorrow's Aircraft and Automobile engines. We now serve both these industries with war material.
STERLING ALUMINUM PRODUCTS
Incorporated
St. Louis, Mo.
LET'S GO! U.S.A.
KEEP 'EM ROLLING
STERLING
PISTONS

Thermatite Treated Transformer for Radio Equipment



Thermatite treated transformer made by the Thermador Electrical Manufacturing Company, Los Angeles, California. It is intended for use in radios and radio equipment, and is said to be suitable for use under conditions of extreme heat and humidity.





PRODUCTION FOR AIRPOWER

Clearing FOR PRODUCTION

Airpower can be ours only when the aircraft industry reaches the ultimate in the production of wing sections, cowlings, spars, and thousands of other sheet aluminum parts.

Modern in design as the sheet aluminum parts it forms, this All Purpose CLEARING Hydraulic Press has attained the highest production rates set by the aircraft production men.

The CLEARING improved design parallels that of the aircraft industry.

Clearing Machine Corporation
6499 West 65th Street, Chicago, Illinois

MECHANICAL AND HYDRAULIC PRESSES

CLEARING

MACHINE CORPORATION

CHICAGO

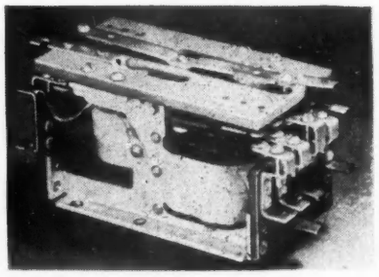
New Production Equipment

(*Continued from page* 45)

Contactor for Aircraft Motors

A NEW three-purpose contactor, the CR2791-Q100, announced by General Electric Company, is designed to start, reverse and provide dynamic braking for d-c split-field, series wound aircraft motors. It is suitable for motors with full-load currents up to 10 amperes and locked-rotor currents of 60 amperes at 12 or 24 volts d-c.

This contactor, which is compact and light, combines in one unit the functions of several single-purpose relays, with their interconnections and mechanical interlocks. All moving parts are statically and dynamically balanced, and the contactor can be mounted in any position on either a metallic or nonmetallic base. It is designed to withstand the 200-hr. salt-spray test prescribed by various Government departments, to operate properly at rated currents in ambient temperatures ranging from 95 C to minus 40 C, and up to altitudes of 40,000 ft., and to operate immediately after a 48-hr. exposure to an atmosphere containing 95 per cent humidity at 75 C.



GE reversing dynamic-braking magnetic contractor.

Owing to the balanced armature design, the contacts will remain in the open or closed position, whether energized or deenergized, when subjected to vibratory movements with frequencies of 5 to 55 cycles per second and an amplitude of 1/32 in. (1/16-in. total travel), in any direction, and when subjected to a linear acceleration equal to ten times that of gravity, in any direction.

Solder Iron Stand

THE Photobell Corporation, New York, N. Y., is making a solder iron stand known as the type SS2, which combines several new features. The work is illuminated by two lamps under the hood, and is viewed through a 5-inch lens of 2, 4, or 6 power. Plate glass ¼-inch thick may be substituted for the lens if desired. A 30-inch chimney removes heat and fumes, and an all-black exterior avoids reflection of light toward the operator. A bracket can be furnished with the stand, to hold a white card, forming a background for the work being done.

The Photobel electric solder iron stand.

Lightweight Pneumatic Drill

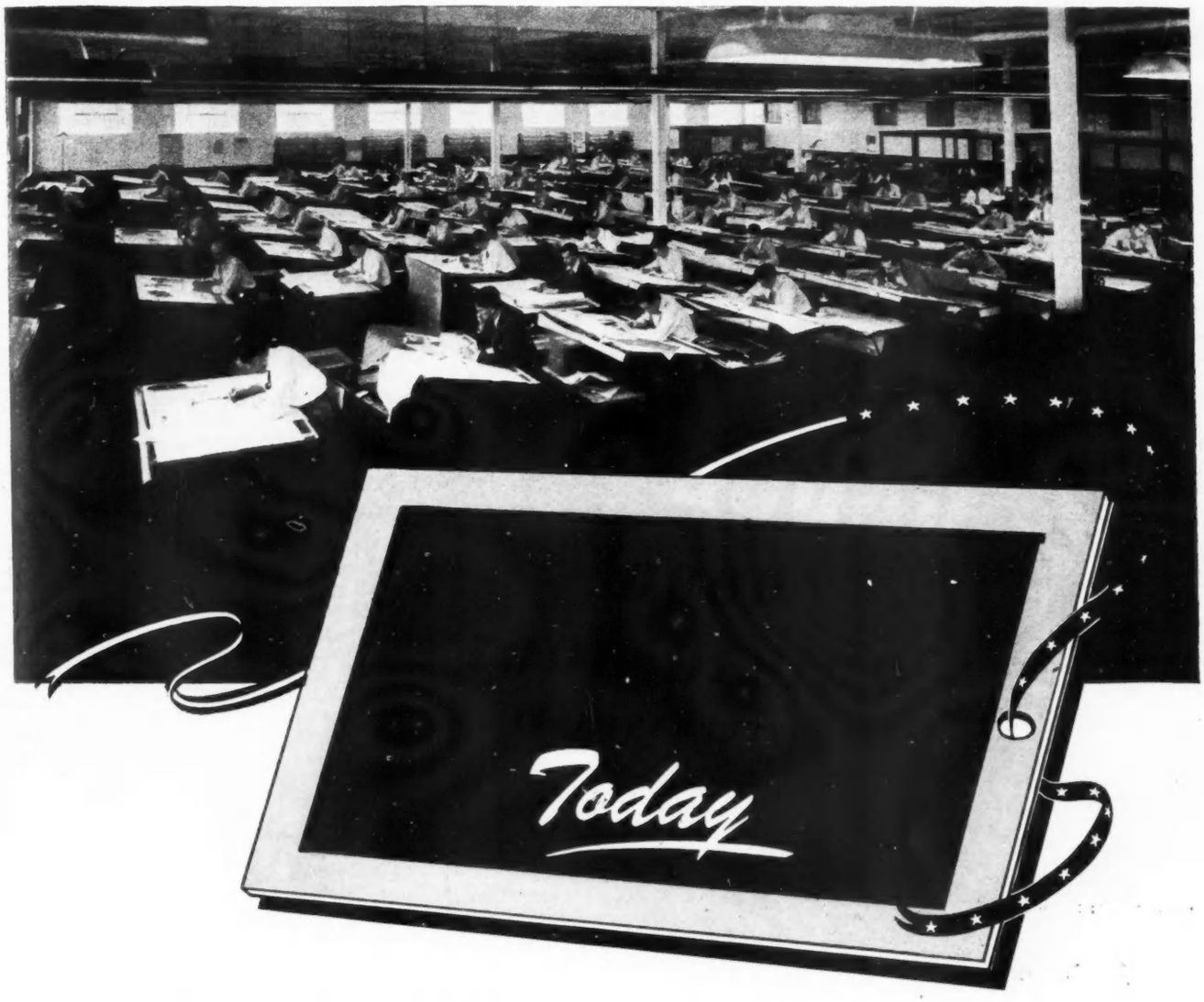
A NEW lightweight pneumatic drill, manufactured by Ingersoll-Rand Company, New York, N. Y., features a built-in speed regulator and a "Multi-Vane" air motor. Known as the size 00A drill, it weighs less than two pounds and is well adapted to production line use, particularly in the manufacture of aircraft. Lubrication is pro-

Clean Air
is a war production necessity
In manufacturing plants throughout the nation geared to war production AAF dust control units are speeding deliveries to our armed forces. Our output today is 100% for war industries where delivery schedules must be maintained and where protection of men and machines against dust has become a definite part of production planning. Shown here are a variety of applications of the Roto-Clone combined exhauster and dust separator which saves space piping and costs. If you have a dangerous or troublesome dust condition write for free bulletins.

AMERICAN AIR FILTERS

AMERICAN AIR FILTER COMPANY, INC., 449 CENTRAL AVE, LOUISVILLE, KY.

IN CANADA, DARLING BROTHERS, LIMITED, MONTREAL, P. Q.



Good tools occupy a key position in the manufacturing program of today. They can be properly designed only when the production processes and gaging operations are fully considered. Dimensional control is always an important function of the tool designer and should be an integral part of the design problem.

The Contract Work Division of Sheffield is composed of engineers who have had the broadest of experience in a very wide range of industries. They also have the advantage of a very close association with the manufacturer of gages and a true appreciation of gaging practice. When Sheffield engineers undertake a tooling program, they are prepared to carry it right from the first preliminary sketch through to final working drawings. The most economical sequence of manufacturing processes, handling, and gaging operations is stipulated.

SHEFFIELD GAGES

SHEFFIELD

If You Are TOOLING-UP for Some New Product, SHEFFIELD ENGINEERS Can Save You Much Valuable Time

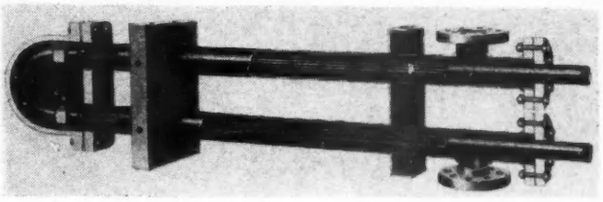
☆

The Ingersoll-Rand Lightweight Pneumatic Drill.

vided by a built-in automatic oiler and a chuck shield offers protection as well as enabling the operator to guide the drill more effectively by grasping the shield with the fingers of the free hand.

Brown Fintube Heat Exchangers

THE Brown Fintube Company, Elyria, Ohio, has taken up the manufacture of ready-to-use heat exchangers. Brown Fintube heat exchangers will be built in all standard types, including the twin-section unit illustrated herewith, and in capacities to meet practically any heating or cooling requirement. Brown Fintubes, in which the fin is welded to the central member, will be used as the heat-transfer medium in all cases.



Heat exchanger of the Brown Fintube Co.

The GAUGE
TELLS THE STORY
2
GRIPS
ARE BETTER THAN ONE
HANSEN
PUSH-TITE
HOSE CLAMPS
Proof of the facts is in the testing. Hansen compression type hose clamps have proven in actual laboratory tests that they will take over 5000 pounds pressure and we recommend a safe working pressure from 800 to 1000 pounds. With Hansen hose clamps it's two grips, one on inside of hose, one on outside, as compared with only one grip found in ordinary hose clamps. Extremely easy to install it's merely a matter of screwing stem into hose, takes but a few seconds. No extra parts or replacements and remember they're very economical—can be used many times over. With Hansen hose clamps it's a two to one advantage. Send for free catalog.
Hansen MFG. CO.
INDUSTRIAL AIR LINE EQUIPMENT
1786 E. 27TH STREET • CLEVELAND, OHIO

Blower for Exhaustion of Gases

CHELSEA FAN & BLOWER CO., Inc., Irvington, N. J., announces a small portable unit for the exhaustion of gases and fumes from enclosed spaces such as ship holds, welding rooms, tunnels, vaults and basements. The unit, which is illustrated herewith, is equipped with a ¾ hp. ball-bearing motor and with newly-developed heavy steel wheels. It sucks or blows 2000 cfm, operates in any position, and weighs only 70 lb. Adapters are provided for either three 4-in. or four 3-in. nozzles for flexible hose, with caps to close the nozzles not in use. Each 4-in. metal hose of 20-ft. length will exhaust 250 cfm, and each 3-in. nozzle more than 200 cfm.

Portable Chelsea blower for exhaustion of gases.

Material for Leaky Cooling Systems

THE du Pont Company has introduced a new material for repairing cracks in cylinder heads, engine blocks, water jackets and valve ports, in its No. 7 line called Motor Weld. According to a laboratory report, cracks are sealed securely without clogging or impairing the cooling system. The compound is said to function as well in alcohol and other standard anti-freeze solutions as in water. Motor weld is poured into the radiator after the water has been warmed by running the engine. The contents of a pint bottle are said to be enough to seal seven large leaks, and if left in the cooling system

HOW TO CEMENT

transparent Du Pont "Lucite"

Information for aircraft manufacturers and their established enclosure suppliers

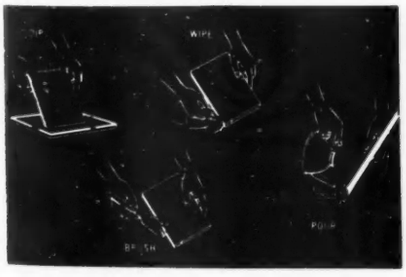
REASONABLE skill and care must be exercised in cementing transparent enclosures made of "Lucite" methyl methacrylate resin to preserve the plastic's crystal clarity and strength.

MONOMER TYPE. There are two general types of cements for joining "Lucite." The first is the monomer type (H-78). Methyl methacrylate monomer is supplied with a catalyst powder contained in a separate capsule. This cement is of the polymerizing type, that is, it sets up to a hard bond through the same chemical processes by which "Lucite" itself is made. The catalyst is, therefore, added as a "starter."

Softening Time

"Lucite" must be dipped when using monomer cement. The plastic surface is softened in about 1 hour and, if pressed to another softened surface, a tough joint will result when the cement has hardened. The softening time will be greatly reduced if the monomer is heated to 45°-50° C (113°-122° F) and held at this temperature during the period of immersion.

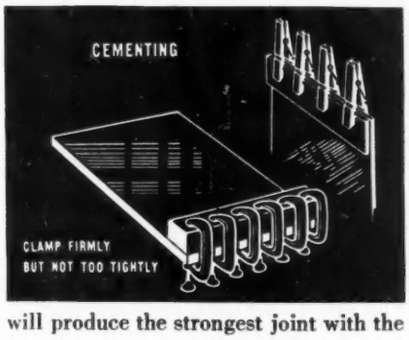
SOLVENT TYPE A second type is solvent cement applied by dipping, brushing, wiping or pouring depending on the type of joint. H-94 cement (containing glacial acetic acid) is recommended as an effective material of this class for it yields a tenacious, permanent bond and may be easily and safely applied with normal care. It may be stored in glass, porcelain or aluminum containers. It is well suited for work where only limited facilities exist.



Softening Time

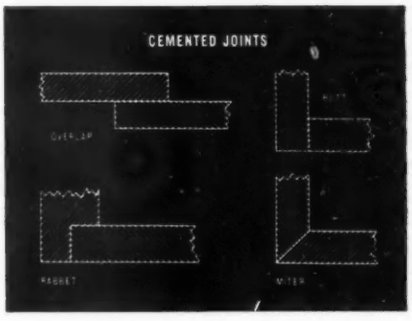
The surfaces to be cemented are first softened by the acid and then pressed together. The cemented piece may be handled with reasonable care after an hour or two, but it should be allowed to stand for 10 to 20 hours if machining is to be done. If it is convenient to warm the cement to 60°C (140°F), the cementing action will be hastened. At this temperature "Lucite" is sufficiently softened by the solvent within two or three minutes to form a firm bond.

FIT CAREFULLY. Careful manipulation is important. The surfaces must be prepared to fit perfectly to avoid entrapped air bubbles. Always remember that a maximum of fitting and a minimum of forcing



will produce the strongest joint with the least impairment of the excellent optical clarity of "Lucite." Instead of high pressures in clamping, use light pressure at many points along the joint. Machined surfaces are preferable to polished surfaces for more satisfactory cementing.

MASK ADJOINING AREAS. It is advisable to mask the areas of the piece adjacent to the surfaces which are to be cemented. This will prevent the solvent from attacking those areas. Cellophane adhesive



tape is suitable for the purpose since it is not affected by the cement.

AVOID LACQUERS AND DOPES. Various types of lacquers or "dopes" may be used, in cases of extreme emergency, when approved cements are not available. The solvents in such preparations, however, will eventually craze or pit the plastic surface.

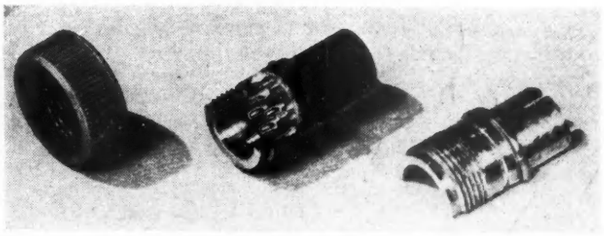
Practically all leading airplane plants are using Du Pont "Lucite" in their airplane enclosures because of its clarity, weather-resistance, light weight and strength. Du Pont also manufactures "Plastacele" cellulose acetate transparent sheeting for light plane, glider and trainer enclosures. Write for new, free manual on fabricating and physical properties of "Lucite" for aircraft. E. I. du Pont de Nemours & Co. (Inc.), Plastics Department-A, Arlington, N. J. . . . and 5801 So. Broadway, Los Angeles, California.

DU PONT "LUCITE"
REG. U. S. PAT. OFF.
METHYL METHACRYLATE RESIN

will prevent other leaks from developing. The fluid is said to have no unpleasant odor and not to be loaded with heavy solid matter that might clog the fine passages of modern radiators.

Cable Connector to Speed Work

A NEW electrical cable connector, of three-piece, split-shell construction is now in production at The Harwood Co., Los Angeles, Calif. Assembly and maintenance are said to be speeded by the simple construction of this die-cast connector. Harwood connectors are supplied in a complete range of sizes from 10S to 48 in the three-piece construction. They conform in all respects to Army-Navy specifications.



The Harwood three-piece cable connector.

Polar Grip Tire Tread

A NEW "Polar-Grip" tire tread that will improve the operating conditions of airplanes in ice-bound territory has been announced by the Firestone Tire & Rubber Company. It is a soft crêpe-rubber tread that is said to give a more nearly positive grip on snow and ice than the conventional airplane tire. The many flexible finger-like projections of the soft tread give a better hold on snow and ice, making possible a more powerful braking action and providing more resistance to skidding. The added traction is especially important where planes have to be landed on small emergency fields and where weather conditions make blind landings necessary.

New tire tread for airplanes

Fuller

FULLER Builds for a Better Tomorrow

BEFORE THE WAR — FULLER made spectacular strides in solving unusual problems of heavy-duty, off-the-highway transmission service.

DURING THE WAR — FULLER facilities are devoted almost 100% to the production of transmissions for vitally important military vehicles.

AFTER THE WAR — The dawn of a new era in highway transportation — for which FULLER will be prepared, with transmissions of the most advanced type.

Today, in the FULLER Plant, the production of transmissions for civilian needs has almost entirely stopped. Instead, our plant is working at full capacity on the units needed by our armed forces.

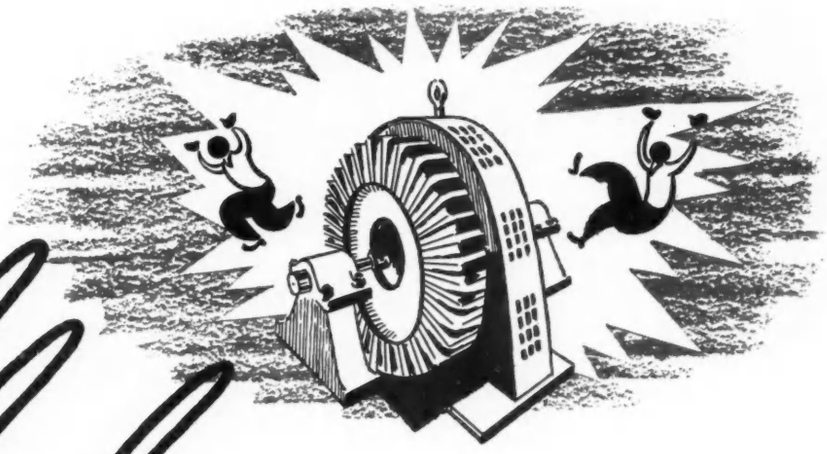
But FULLER engineering brains have not stopped. In solving the problems of making transmissions for grueling military service, FULLER engineers are forming new concepts of transmissions for the heavy-duty service of tomorrow.

And, when that new and brighter tomorrow comes, FULLER will be ready to supply new and finer transmissions, even as FULLER was ready at the start of this war for full scale production of the units needed by our government.

FULLER Mfg Co., Kalamazoo, Mich.

New Quenching Oil for Low-Alloy Steels

TECHNOLOGISTS of the Gulf Research & Development Company, a subsidiary of the Gulf Oil Corporation, have developed a new quenching oil specially suited to low-alloy steels. It is known as Gulf Super Quench and is said to give cooling rates approaching that of water through the higher temperature range. Improved physical properties are said to have been obtained in most of the steels tested, without increase in distortion or the tendency to crack. The tests were carried out with equipment specially developed for the purpose at the Gulf Research & Development Company's laboratory near Pittsburgh. This comprises an oscillograph which records the changing electromotive force of a thermal couple embedded in the steel as it is being quenched. The oscillogram is recorded on a sensitized tape which is drawn through the camera by a motor at a speed of 6 in. per second. From this record the change in the tempera-



Flashover AT 10 PM

back on the line next afternoon at 3

200 KW GENERATOR FLASHED OVER AND GROUNDED—WAR PRODUCTION HALTED AT 10 PM. UNIT DISMANTLED, NEW BRUSHHOLDER INSULATION TUBES MADE UP (BY NEAREST WESTINGHOUSE MANUFACTURING & REPAIR PLANT), RUSHED BACK TO THE PLANT AND INSTALLED. GENERATOR BACK ON THE LINE AT 3 PM. SEVENTEEN HOURS FROM PRODUCTION STOPPAGE TO PRODUCTION AS USUAL.

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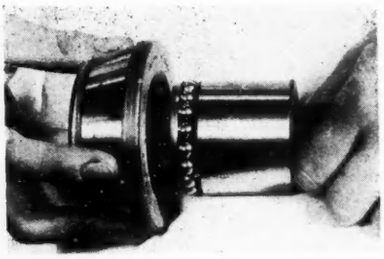


Emmerton slug gage with ball-bearing pilot made by the British Timken Co.

ture of the steel during any interval of 0.02 sec. can be determined.

It is stated that there is no reason for using Super Quench in cases where ordinary quenching oils always give the desired hardness in heat-treating steel of a given specification, nor in cases where water is being used as the quenching medium without trouble from distortion or cracking; where it can be used to advantage is in the hundreds of cases intermediate between these two extremes, involving both alloy and plain carbon steels.

New Plug Gage Has Ball-Bearing Pilot

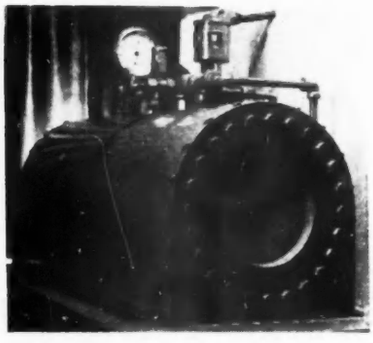
DEVELOPED originally for use in its own plant, a new type of plug gage has been put on the market in England by the British Timken Co. It is claimed to avoid loss of time and damage to both gage and work due to faulty angle of approach, to increase the rate and accuracy of inspection and to permit working to closer tolerances.

As shown in the accompanying illustration, the gage has a ring of steel balls in an annular groove close to the leading edge. The depth of the groove and the diameter of the balls result in the latter being exactly flush with the cylindrical surface of the body of the gage. Free to rotate, the balls guide the gage into the hole and automatically effect alinement. Even though the gage diameter exactly equals that of the hole it can be inserted easily and fewer rejects are said to result from inserting the gage in the minimum hole.

Known as the Emmerton gage, it is claimed also to have a longer life than the conventional type.

Tank for Liquid Carbon Dioxide

AN item of scientific interest has been developed by the Cardox Corp., to demonstrate the Cardox principle of storing liquid carbon dioxide under engineered control. The miniature storage



tank shown here holds liquid carbon dioxide at a pressure of 300 psi. The end plates are fitted with two, one-inch layers of Lucite so as to make it possible to observe the phenomenon of liquid CO_2, when suitably illuminated.

Tool for Terminal Installations

THREE crimps are made at one time by the new "Hand-Die" installation tool announced by Aircraft-Marine Products, Inc., Elizabeth, N. J., for use with their Diamond Grip solderless insulation support terminal. This new tool is so designed that unskilled workers can achieve production line efficiency without a long training period.

An insertion gage positions the terminal; the crimping jaws are in reality dies of tool steel adjustable to accommodate various insulation and wire diameters. The self-opening handles have a ratio of 15 to 1, which makes for easy operation. When the jaws are closed tightly, a perfectly crimped connection has been made, and there is no choice of pressure necessary by the operator.

Announcing

A Series of

6 TRAINING FILMS

For your use in the training of new men, apprentices, and personnel being converted to war work

on DESIGN, BRAZING, APPLICATION, GRINDING OF CARBIDE TOOLS

We announce—for use in your plant—a series of six training films covering the fundamentals of carbide tool manufacture, design, brazing, application and grinding. Based on more than a decade of experience in the art of cemented carbide use, the films are designed to speed the training of new men, apprentices, and those being converted to carbide tool use in the metal working industry. Also suitable as "refresher courses" for those with working knowledge of carbide tool use but who wish to review the latest techniques. Technically known as "film strips"—containing illustrations and explanatory text—these films are designed for step-by-step training in the following subjects:

Not Motion Pictures
Carboloy training films are technically known as "film strips", or silent slide films (35mm), containing illustrations and explanatory text for detailed training purposes.

SUBJECTS

Film No. 1—"WHAT IS CEMENTED CARBIDE?"
Designed to provide a knowledge of what cemented carbide is, physical characteristics, and how made. Valuable as a basis for understanding reasons for recommendations in subsequent films.

Film No. 2—"DESIGNING CARBOLOY TOOLS"
Reviews for tool designers, the special requirements necessary in designing tools with carbide tips. Covers tool styles, tip and shank sizes, rakes, etc., for single point tools.

Film No. 3—"BRAZING CARBOLOY TOOLS"
Detailed, step-by-step procedure for torch brazing carbide blanks to steel shanks. Includes brazing of single and multiple point tools, how to renew worn-out H.S.S. cutters with carbide tips, etc.

Film No. 4—"CHIP BREAKERS"
Shows how to determine most efficient chip breakers for carbide steel cutting tools; how to adjust to meet individual conditions, and step-by-step procedure for grinding rapidly and accurately.

Film No. 5—"GRINDING CARBOLOY TOOLS"
Step-by-step grinding procedure for single point carbide tools from brazed, damaged and ordinary dulled states. How to rough rapidly and finish accurately. Equipment, wheels, accessories.

Film No. 6—"PUTTING CARBOLOY TOOLS TO WORK"
Important for the operator applying carbide tools. In three parts: Part I—Putting tool on machine. Part II—The machine. Part III—Trouble shooting. What to do when the job doesn't "click".

AVAILABLE FOR PERMANENT USE AT COST OF PRINTS ONLY

So that industrial concerns and educational institutions may incorporate these films as a permanent part of their war training program, prints are available for purchase at approximate print cost of $20.00 for set of 6. (Entire cost of film production has been absorbed by Carboloy Company.) One complete set of six reference manuals and one instructor's manual included.

CARBOLOY COMPANY, INC., DETROIT, MICH.
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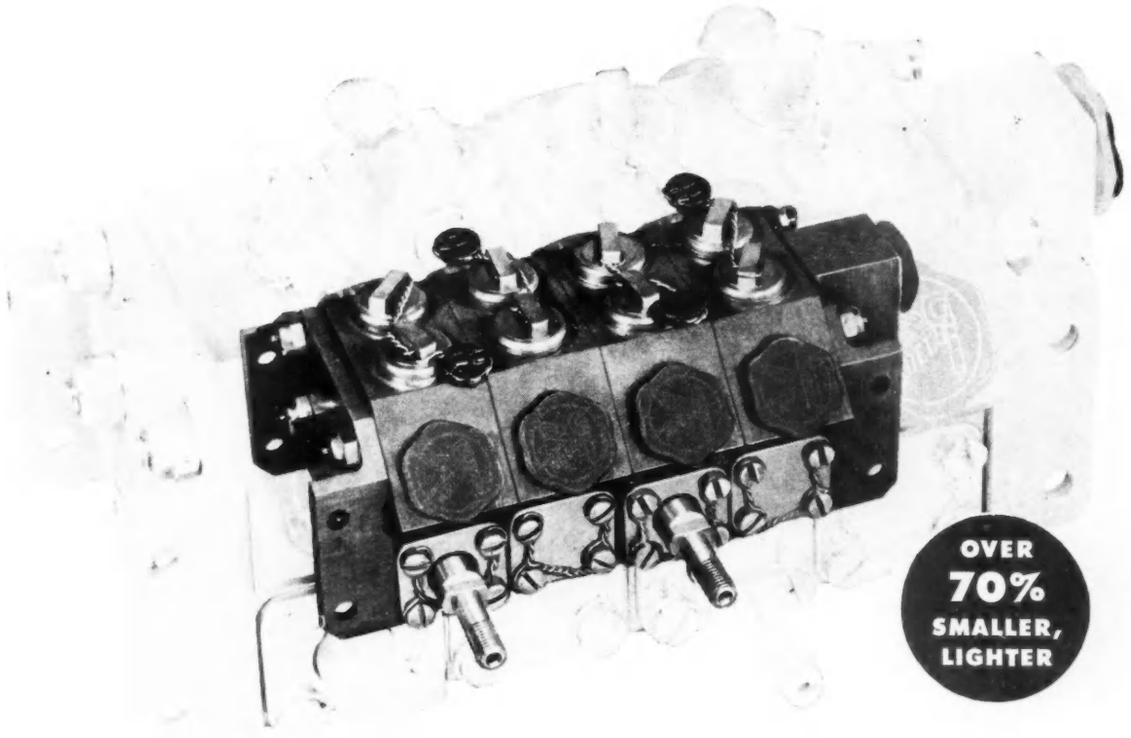

Smaller Space – BIGGER PROBLEM

AIRCRAFT and industrial engineers faced with the problem of installing bulky controls in limited space will welcome the new ADEL Stacking Midget. Utilizing the original ADEL Single Unit Mighty Midget 4-Way Hydraulic Selector Valve which revolutionized previous conceptions by offering space savings of 72% and weight savings of 76%, with performance characteristics actually superior to predecessor models, Stacking Midgets permit the installation of several small size, high capacity valves in a closely confined area. Quadruple Unit illustrated measures only $5\frac{31}{32}$" x $3\frac{3}{16}$" x $2\frac{7}{16}$" with flanges and shafts; weighs only 2.9 lb.

Any number may be clamped together by means of "thru" bolts and end plates which also serve as mounting brackets. All units are interchangeable. Symmetrical design permits turning end-for-end to secure desired shaft arrangement. Individual valve assemblies may be replaced by breaking only the two cylinder lines affected. Over-travel is prevented by an integral stop located on the camshaft. Normal servicing may be done by relatively unskilled persons without special tools.

In compliance with ADEL policy, individual working parts in the entire Midget Group are standardized to permit interchangeability between models and operating parts, economy in part stocks and maximum service facility. Bodies fabricated from dural bar stock to assure uniform strength, freedom from porosity, maximum dependability with minimum size and weight. Valve and camshaft assemblies manufactured from stainless steel, heat-treated to assure long service life. Critical dimensions obtained by grinding, micro-finishing and polishing on specially designed ADEL equipment.

Contact nearest Engineering Service office for complete performance data and installation recommendations. Existing regulations permit submission of complete information only to individuals affiliated with recognized armament industries.

ADEL

PRECISION PRODUCTS CORP.

BURBANK, CALIFORNIA

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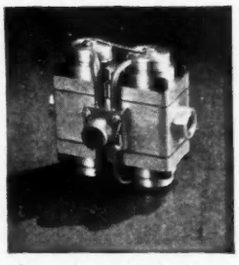

Above: Type AV-7, 4-way selector valve.

Above: Type AV-14, hydraulic selector valve.

Above: Type AV-5, electric diaphragm valve.

hi-g*

*TRADE MARK—hi-g indicates positive ability to operate in any position regardless of vibration, change of motion or acceleration.

WRITE FOR ILLUSTRATED & DESCRIPTIVE BULLETIN

GENERAL CONTROLS

PIONEERS AND LEADERS IN THE DEVELOPMENT AND MANUFACTURE OF MAGNETIC VALVES

801 ALLEN AVENUE, GLENDALE, CALIFORNIA

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Power Recovery In Testing Aircraft

(*Continued from page* 28)

shut down. The rotor of the magnetic coupling, which is secured to the rotor of the alternator, is then held stationary by a large, air-operated brake, and the magnetic coupling is used as an absorption or eddy-current dynamometer. The engine is then loaded, by exciting the field of the coupling, to any desired degree, at all test speeds, up to and including the engine crankshaft speed corresponding to the synchronous speed of the alternator. During this part of the test, which corresponds to a relatively small fraction of the total test time, all power is absorbed by the magnetic coupling and dissipated as heat in the cooling water. After completing this portion of the test, the air brake is released and the alternator again connected to the power line, to be used as a power-recovery unit.

At all engine speeds above the synchronous speed of the alternator, the magnetic coupling acts as a slip coupling to transmit the power of the engine to the alternator. In this way the alternator and magnetic coupling load the engine, by delivering generated energy to the power lines and by absorbing a lesser amount of energy due to the slip between the engine propeller shaft and the alternator.

A marked difference in torque characteristics between a conventional electric clutch and the magnetic clutch used should be noted, to realize the advantages of unsual features, of the particular coupling system used in this installation.

Consider a variable-speed airplane engine on the input shaft of a slip coupling and a constant-speed synchronous alternator on the output end, with fixed excitation of the coupling field. As the engine input speed is increased, the slip in the coupling is increased, because the output speed remains constant at the synchronous speed of the alternator, which is held in synchronism by its connection to the power line.

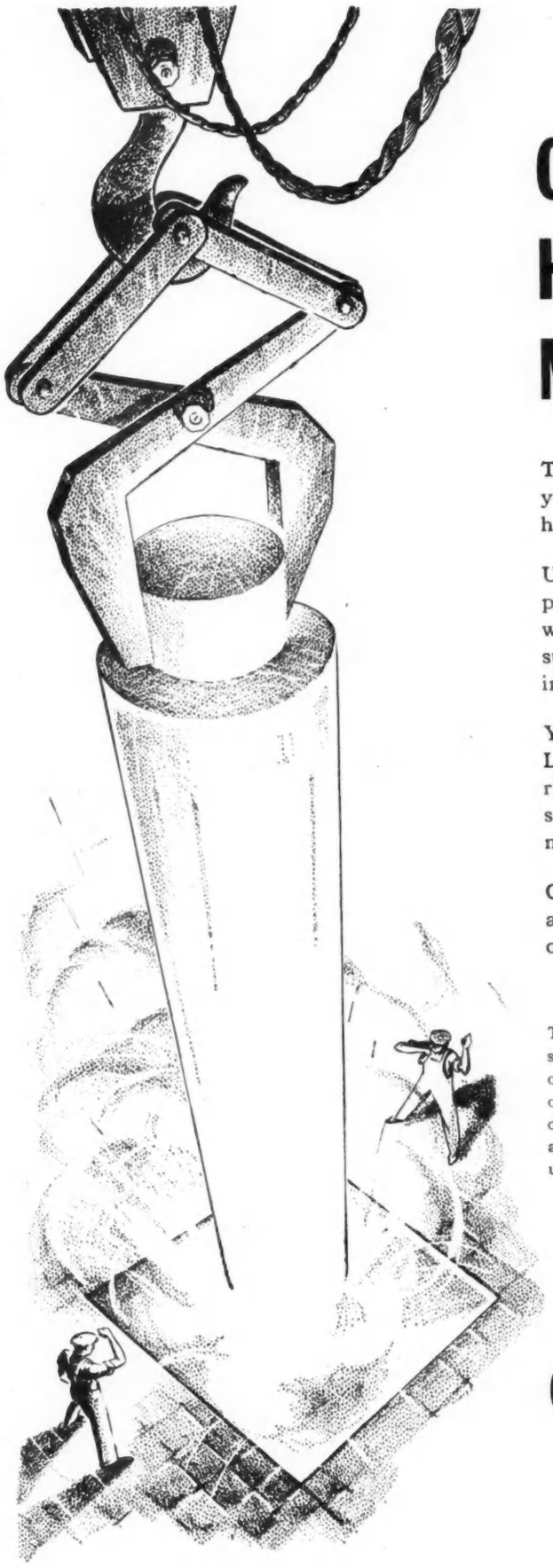
With a conventional type electric clutch, the torque at the output shaft increases with the slip till a point is reached at which, and beyond which, increased slip causes a rapid decrease of output torque. With the magnetic coupling used here, increased slip also causes increased torque; but no point is reached at which torque decreases with increased slip. As a result the efficiency is remarkably high. This characteristic also contributes much to stable speed control.

Excitation of the magnetic coupling is obtained from direct-current supply. The field of the coupling is in the output circuit of a pair of gas-filled, grid controlled tubes, so connected that full wave rectification of the AC source is effected. These two tubes furnish the basic field excitation to the magnetic coupling.

With the engine throttle set slightly below any given engine test speed, a basic control potentiometer is adjusted to keep these tubes firing. This potentiometer, across the filtered output of a small rectifier circuit, is connected in the grid circuit of these tubes and keeps a basic amount of field excitation on the coupling. This is not critical but serves to keep the engine and alternator coupled.

A second similar tube is placed in parallel with each of the above described basic current tubes. This second pair of tubes are the speed-control tubes. They obtain an adjustable grid-control potential from a second potentiometer across the output of the rectifier mentioned above. This potentiometer can be adjusted to bring the speed control tubes into, or keep them out of control. When the basic field is first applied, this speed-control potentiometer is adjusted to prevent speed-control-tube operation.

With the speed-control potentiometer adjusted to raise this negative grid potential to any point where it crosses the critical grid potential of the tube, each tube will fire during the last quarter cycle of positive-anode voltage, and any point on the first quarter cycle can be selected to begin



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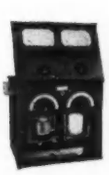
A NOVEL INSTRUMENT

The Cities Service Industrial Heat Prover is a special instrument developed by the Cities Service Research Laboratory. It enables those engaged in the oxygen control of furnace atmospheres to achieve certain physical results desired in the processing of metal, or in the control of the amount of combustibles present. Recordings are continuous and almost instantaneous. Full informationon request.



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firing. However no point on the last quarter cycle can be selected to start firing the tube, as the controlled DC grid potential will cross the critical grid at the half way point in the half cycle.

By super-imposing a rider wave on the potentiometer-controlled grid bias, it is possible to start the tube firing at any point on the half cycle wave of anode voltage. This low voltage AC rider wave lags behind the anode voltage by 90 degs and is obtained by means of a Scott Tee connected transformer arrangement.

The speed tubes have a second source of grid potential, obtained from an Alnico speed-governing generator, which is connected to the input shaft of the magnetic coupling. This AC generator has a wide, direct variation of voltage within a narrow range of speed variation. The AC potential generated is stepped up, rectified and filtered, before introduction into the grid circuit of the speed tubes.

When the speed-control potentiometer is adjusted to bring the speed-control tubes into operation, the following action takes place. An increase of a few RPM of engine input speed, increases the positive DC potential of the governor generator output, which is introduced into the grid circuit. This has the effect of automatically raising the constant negative grid bias, as determined by the setting of the speed-control potentiometer, toward zero cathode or positive-grid potential, and causes the tube to fire. This tends to increase excitation of the coupling momentarily and, so-to-speak, stiffen the clutch. As the alternator speed can not change, and increased excitation reduces slip, the engine speed will decrease. In like manner a decrease of engine speed, with the governor in operating control, will decrease excitation of the coupling and cause the engine speed to pick up.

After adjusting the speed-control potentiometer to any pre-determined engine crankshaft speed, it is possible to greatly reduce the basic excitation control. The governor will still automatically hold the engine speed constant, because of the extremely rapid, sensitive response of the control circuit.

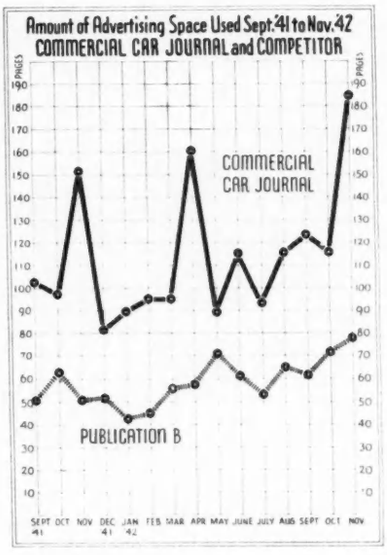
It becomes apparent that, after setting the speed control at a given speed setting, the operator can adjust the throttle to any setting he wishes. The engine will hold its pre-determined speed, and deliver any power to the coupling, up to the capacity of the engine at the speed held, depending on the throttle setting chosen.

A discharge tube, connected between the anodes and cathodes of the basic and speed control tubes, serves to prevent short tube life due to high inverse anode potentials.

Sketches showing the power recovery system, the electronic control circuit, and speed-control tube potentials are included.

The electronic control circuit used was designed and built by the manufacturer of the magnetic coupling. It was coordinated with the various other control circuits and features, involved in the complete engine test apparatus used, by the close collaboration of H. E. Hardenbrook, works engineer; L. R. Grandy, assistant superintendent of engine test, and the writer.

COMMERCIAL CAR JOURNAL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41 42

Leads in Advertising Volume

The chart, of course, tells the story of COMMERCIAL CAR JOURNAL leadership. Any publication, head and shoulders above the others in its field, has the confidence of the manufacturers in its industry —and is getting results for them.

We started making these charts in 1935. They all look about alike — with COMMERCIAL CAR JOURNAL always out in front. It is the No. 1 Truck Fleet publication, with 30,000 circulation monthly.

COMMERCIAL CAR JOURNAL

A Chilton Publication

Chestnut & 56th Sts. Philadelphia, Pa.

X-Ray Technique Aids Development Work

(*Continued from page* 46)

technique has unplumbed possibilities as an adjunct to metallurgical investigation. The C-W-C staff is carrying on experimental work not only in the solution of practical foundry problems but also in the development of methods to further enhance the usefulness of the X-ray as a laboratory tool. One such project, looking to the future, is a study of stereoscopic techniques which may make possible a definite measurement of the exact location of faults directly from an examination of the film. The X-ray laboratory, erected at a cost of $100,000, is a fitting complement to the spectrographic laboratory installed several years ago.

More than a MILLION MILES and still in there "Fighting"

This Waukesha-powered FWD truck, owned by Clintonville Transfer Line, Inc., Clintonville, Wis., has a service record of more than a million miles. Driver Lewis Schall smiles with satisfaction as he checks the Waukesha Engine's low oil consumption.

★ Too old for active service—not *this* FWD truck! Sure, it's got more than a million miles on it. And what if it was built back in 1933? It's got the same type of engine it started out with—Waukesha Marathon Six. The 6-B Series they call it.

If there were any weak spots in that Waukesha Six design, they'd have showed up long before now.

This truck got better than 400,000 miles from *each* of the first two engines before replacing 'em. That's at least 2,100,000,000 revolutions *apiece*—just about the equivalent of 20,000 hours' continuous service from each engine. And now, with its third Waukesha Engine, it just keeps rolling along . . . .

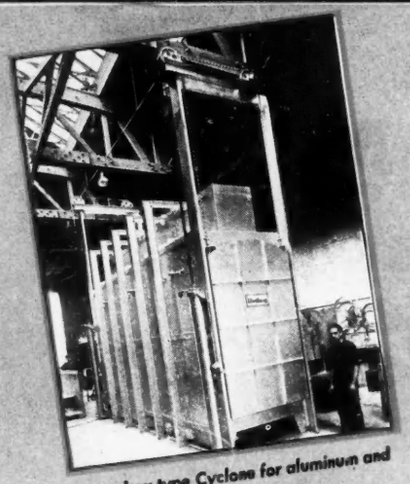
In a war like this, every truck that will run is very much a part of war transportation. So this truck is still in there fighting—hauling engines from Waukesha to Clintonville, Wis.—new modern Waukesha Engines *to power the very latest type of war vehicles.*

For Automotive, Industrial and Stationary Power, Waukesha Gasoline and Oil Engines range from 5 hp. to over 300 hp. *Get Bulletin 1079.*

WAUKESHA MOTOR COMPANY, WAUKESHA, WIS.
NEW YORK • TULSA • LOS ANGELES

MORE POWER FOR VICTORY

WAUKESHA ENGINES



Large box type Cyclone for aluminum and magnesium heat treatment.

Small box type Cyclone for tempering tools and dies or other work that is handled individually.

Large vertical type Cyclone for production tempering. Its accuracy of heating and control also makes it ideal for aluminum and magnesium heat treatment.

Small vertical type Cyclone Furnace for heat treating small parts. Note basket in lower right hand corner.

THIS IS ABOUT THE SIZE OF IT!

SPECIFY STANDARD SIZES when ordering heat treating equipment. Valuable time is saved because drawings are available and all engineering has been completed. Man hours are saved by the elimination of special work in both engineering and the shop. And heat treating furnaces are sped to their destination to do their chosen work.

The dimensions listed below represent standard sizes of both vertical type and box type Lindberg Cyclone Furnaces. Each of these furnaces has been engineered and built and installed in the field.

The sizes embrace a range wide enough to handle practically any heat treating job for temperatures up to 1250°F.

LINDBERG VERTICAL TYPE CYCLONE *FUEL FIRED*

Utilizes the famous Lindberg 100% forced convection heating principle, available in both fuel fired and electrically heated units. Work is handled in baskets or on fixtures for accurate, uniform, low-cost tempering and precision heat treatment of aluminum and magnesium castings and forgings. Temperatures from 250°F. to 1250°F.

Dia.	Depth	Dia.	Depth	Dia.	Depth	Dia.	Depth	Dia.	Depth	Dia.	Depth
12″	16″	22″	30″	25″	40″	28″	60″	38″	30″	48″	38″
12″	100″	22″	36″	25″	48″	28″	72″	38″	36″	48″	48″
16″	20″	22″	38″	25″	60″	33″	28″	38″	48″	48″	60″
16″	22″	22″	48″	25″	160″	33″	36″	38″	60″	48″	78″
16″	26″	22″	60″	28″	28″	33″	40″	38″	72″	60″	72″
16″	28″	22″	72″	28″	36″	33″	48″	38″	84″	72″	24″
16″	32″	25″	20″	28″	42″	33″	60″	43″	48″	74″	72″
16″	36″	25″	30″	28″	48″	33″	72″	43″	54″	74″	86″
22″	26″	25″	36″	28″	50″	38″	28″	48″	28″	100″	44

ELECTRICALLY HEATED

Dia.	Depth	Dia.	Depth	Dia.	Depth	Dia.	Depth	Dia.	Depth	Dia.	Depth
8″	10″	16″	26″	22″	80″	25″	66″	33″	120″	48″	36″
8″	12″	16″	28″	22″	100″	28″	28″	38″	36″	48″	60″
10″	14″	16″	32″	25″	20″	28″	36″	38″	48″	48″	72″
10″	20″	16″	48″	25″	30″	28″	48″	38″	60″	48″	84″
12″	16″	22″	26″	25″	36″	28″	54″	38″	72″	48″	96″
12″	18″	22″	36″	25″	40″	28″	60″	38″	84″	60″	60″
12″	20″	22″	48″	25″	42″	28″	72″	38″	120″	60″	72″
16″	20″	22″	60″	25″	48″	28″	84″	43″	42″	60″	84″
16″	24″	22″	72″	25″	60″	33″	36″	43″	48″	60″	93″

LINDBERG BOX TYPE CYCLONE *FUEL FIRED*

Is also heated by 100% forced convection and is also available in both fuel fired and electrically heated units. Recommended for tempering tools or dies or other work that is handled individually. Its heating accuracy and control make the box type Cyclone ideal for heat treating aluminum and magnesium castings, stampings and forgings. Temperatures from 250°F. to 1250°F.

W.	D.	H.	W.	D.	H.	W.	D.	H.	W.	D.	H.	W.	D.	H.
12″	16″	18″	24″	36″	18″	30″	72″	24″	36″	72″	36″	60″	96″	42″
15″	24″	18″	24″	48″	18″	36″	22″	24″	36″	92″	24″	72″	12′	42″
17″	24″	18″	24″	24″	20″	36″	36″	24″	42″	72″	36″	—	—	—
18″	36″	18″	30″	48″	40″	36″	54″	30″	48″	12′	60″	—	—	—
24″	24″	18″	30″	48″	48″	36″	72″	30″	54″	72″	36″	—	—	—

ELECTRICALLY HEATED

W.	D.	H.	W.	D.	H.	W.	D.	H.	W.	D.	H.	W.	D.	H.
12″	16″	18″	24″	24″	18″	36″	72″	24″	48″	72″	36″	60″	60″	42″
12″	12″	10″	24″	36″	18″	40″	96″	24″	48″	72″	48″	60″	10′	42″
15″	24″	18″	24″	36″	30″	42″	16′	36″	48″	72″	60″	60″	10′	60″
15″	24″	24″	24″	48″	18″	42″	16′	66″	48″	96″	36″	60″	16′	60″
15″	30″	18″	28″	28″	36″	42″	72″	36″	48″	10′	72″	66″	15′	66″
15″	48″	18″	30″	30″	24″	42″	84″	42″	48″	12′	72″	66″	16′	76″
18″	36″	18″	33″	34″	30″	42″	14′	36″	48″	16′	72″	66″	25′	76″
20″	24″	18″	36″	36″	24″	48″	60″	30″	48″	18′	72″	72″	96″	84″
20″	30″	18″	36″	48″	24″	48″	66″	48″	48″	22′	66″	72″	12′	92″
20″	36″	18″	36″	54″	30″	48″	72″	30″	52″	84″	20″	84″	96″	92″

LINDBERG ENGINEERING COMPANY

2446 WEST HUBBARD STREET • CHICAGO

HYDRYZING FOR SCALE-FREE AND DECARB-FREE HARDENING

LINDBERG FURNACES

SUPER-CYCLONE FOR HARDENING, NORMALIZING, ANNEALING, TEMPERING, NITRIDING

SAYS THE MAN who knows his bearings, "because heavy loads are taken in stride by high-capacity Hyatt Hy-Load Roller Bearings."

That's why, in America's drive for more and more production... with machinery geared up to punishing speeds you'll find Hyatts carrying the load. And in the Tanks... Trucks... Guns... Ships... Planes, which these machines build, Hyatts are also serving.

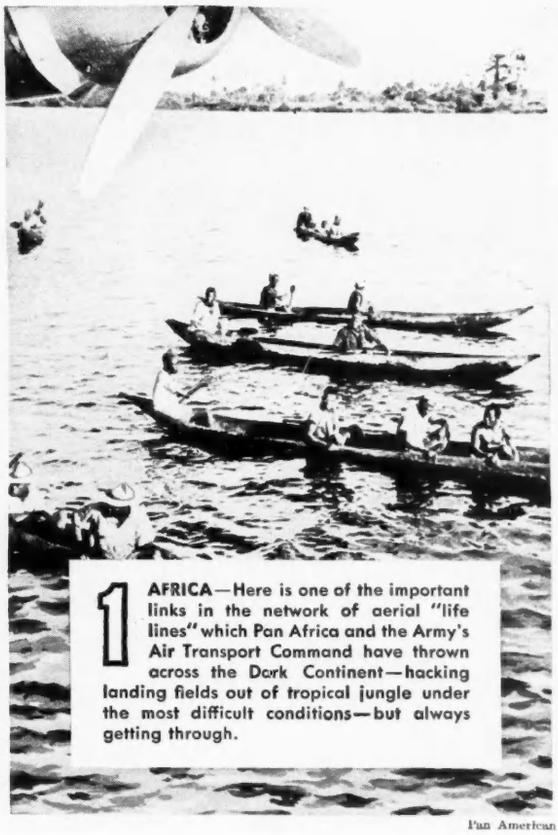
Yes, the men who know their bearings say, "I'll take the Hyatt Hy-Load Bearing for tough jobs." And to back up their judgment are fifty years of Hyatt application in all types of industrial, automotive, and farm equipment... without ever letting the builders down.

Nor will they let Uncle Sam down for, as they guard the machines that run farms and factories, they also carry the bearing loads of the machines that fight.

Hyatt Bearings Division, General Motors Corporation, Harrison, N. J.

THE 50TH YEAR OF HYATT ROLLER BEARINGS

FAMOUS LIFE LINES



1 **AFRICA**—Here is one of the important links in the network of aerial "life lines" which Pan Africa and the Army's Air Transport Command have thrown across the Dark Continent—hacking landing fields out of tropical jungle under the most difficult conditions—but always getting through.

Pan American

2 **MARINE CORPS "CROCODILES"** have landed and have the situation well in hand, with their loads of reconnaissance trucks, tanks and scout cars, all with life lines—oil lines, fuel lines, brake lines, and many other tubing parts—made of Bundy Tubing.

Official Photograph U. S. Marine Corps

AT LAST, the "battle of production" is bearing its deadly fruit. At last, the flood of American-made weapons and equipment is making itself felt in combat on every front and continent.

Each day brings new stories of heroic action. Of tanks, jeeps, trucks and guns. Of bombers, fighters, transport planes and parachutes. Of submarines, PT boats, mine sweepers, carriers and destroyers.

It is a source of pride to us that Bundy life lines, of Bundy Tubing, are on the job in all these—and many more of America's fighting units.

Wherever fuel or lubrication lines are needed, wherever hydraulic pressure or refrigerants must be transmitted, or wherever mechanical or structural tubing is required, Bundy Tubing fills the need. Bundy Tubing Company, Detroit, Michigan.

Official Photograph
U. S. Army Air Forces

GLIDERS—War demands have added many sizes and types of tubing to the Bundy line. Among them is a structural tubing for gliders which is already winning favor among manufacturers of this new and important addition to American air forces.

Buy U. S. War Bonds — Get in Your Scrap

BUNDY TUBING

ENGINEERED TO YOUR EXPECTATIONS

BUNDYWELD double-walled steel tubing, hydrogen-brazed, copper-coated inside and outside. From Capillary sizes up to and including $\frac{1}{4}$" O. D. This double-walled type is also available in steel, tin-coated on the outside, and in Monel.

BUNDY ELECTRICWELD steel tubing. Single-walled — butt welded — annealed. Available in sizes up to and including 2" O. D. Can be furnished tin-coated outside in smaller sizes.

BUNDY "TRIPLE-PURPOSE" tubing. Double-walled, rolled from two strips, joints opposite, welded into a solid wall. Available in all Monel; all steel; Monel inside—steel outside; Monel outside—steel inside. Sizes up to and including $\frac{5}{8}$" O. D.

An example of Muskegon's final inspection operations is this view of the barrel gage inspection of gap opening.

DETAILED INSPECTION

MUSKEGON Piston Rings

Whether their ultimate use is destined to be in automobile, truck or tractor — as in the days of peace — or aircraft, jeep or tank in these days of war, every dimension and feature (*) of Muskegon rings is inspected to rigid standards.

Thus is performance in the field pre-determined and assured.

Let the broad experience of Muskegon engineers help you. Put your piston ring problems up to us.

MUSKEGON PISTON RING CO.

Muskegon, Michigan

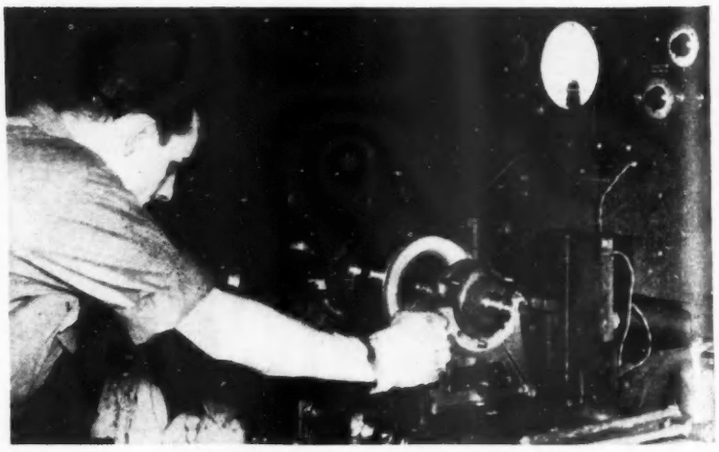
Plants at Muskegon and Sparta

MUSKEGON MPR PISTON RINGS

WATCH IT, Professor! You're about to lose something—*your balance!* And that might cut short your whole career!

And to men in the field of mechanics, balance is no less important! In any assembly where parts rotate at high speeds, unbalanced static and dynamic forces mean vibration and noise. They mean excessive wear—a short life and a not-so-merry one!

Gisholt Balancing Machines enable you to measure unbalance vibrations as small as .000025". Because you can now do it so accurately, so quickly, so economically —no vital rotating members in any good machine need pay the heavy penalty imposed for unbalance.



GISHOLT DYNETRIC MACHINES *indicate corrections required for all unbalanced forces—in a matter of seconds—and reduce costs accordingly. Literature on request.*

GISHOLT

GISHOLT MACHINE COMPANY, 1205 East Washington Avenue • Madison, Wisconsin

LOOK AHEAD . . . KEEP AHEAD . . . WITH GISHOLT IMPROVEMENTS

TURRET LATHES • AUTOMATIC LATHES • BALANCING MACHINES

THIS ELIMINATES THIS!

THE OLD WAY
Right hand reaching for lock washer and left hand for screw and bringing them together to assemble.
Placing assembled unit in position with left hand and bringing driver towards work with right.

Candid Proof

OF IMPORTANT TIME SAVINGS!

The camera tells you how SEMS Fastener Units save vital production time. No wasted motions—no chance to "forget" the lock washer! A perfect fastening for "green" workers. With only one unit to handle, it speeds driving! Inventories always balance and one order covers both parts. Take advantage of this pre-assembled unit—let your workers try it! Handy kits of assorted testing samples are ready—write for yours now!

SHAKEPROOF inc.

"FASTENING HEADQUARTERS"

2501 North Keeler Avenue, Chicago, Illinois

Distributor of Shakeproof Products Manufactured by
ILLINOIS TOOL WORKS

In Canada: Canada Illinois Tools, Ltd., Toronto, Ontario

SEMS FASTENER UNITS · THREAD-CUTTING SCREWS · LOCK WASHERS · COWL FASTENERS · LOCKING AND PLAIN TERMINALS · LOCKING SCREWS · RADIO AND INSTRUMENT GEARS · SPECIAL STAMPINGS

SEMS

REG. U. S. PAT. OFF.

FASTENER UNITS

PRE-ASSEMBLED SHAKEPROOF LOCK WASHER AND SCREW

INDUSTRY SHOOTS PRODUCTION MINUTES

MICROHONING MAKES MORE HITS

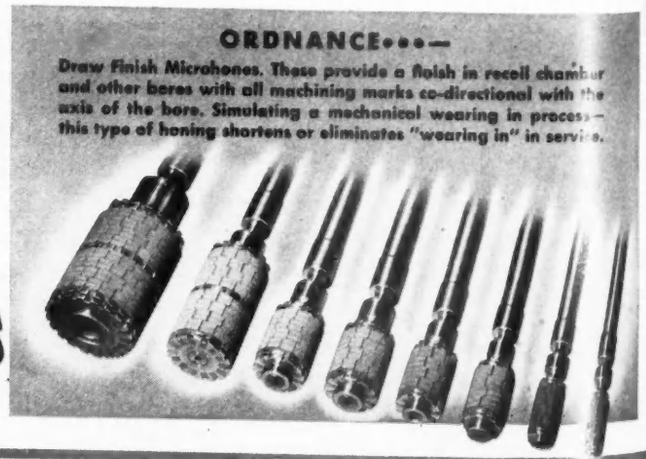
SAVE TIME
★
SAVE METAL
★
SAVE COST
★
IMPROVE QUALITY
★
WITH MICROHONING

DIESEL•••—

24" Microhone for Diesel engine liners. Extra miles per hour in submarines, mine sweepers and similar marine engines require the controlled accuracy provided by Microhoning.

ORDNANCE•••—

Draw Finish Microhones. These provide a finish in recoil chamber and other bores with all machining marks co-directional with the axis of the bore. Simulating a mechanical wearing in process—this type of honing shortens or eliminates "wearing in" in service.



ORDNANCE•••—
Large Microhones for gun barrels.

Micromatic Hones have lowered the time required for final sizing and surface finishing operations from days and hours to minutes and seconds.

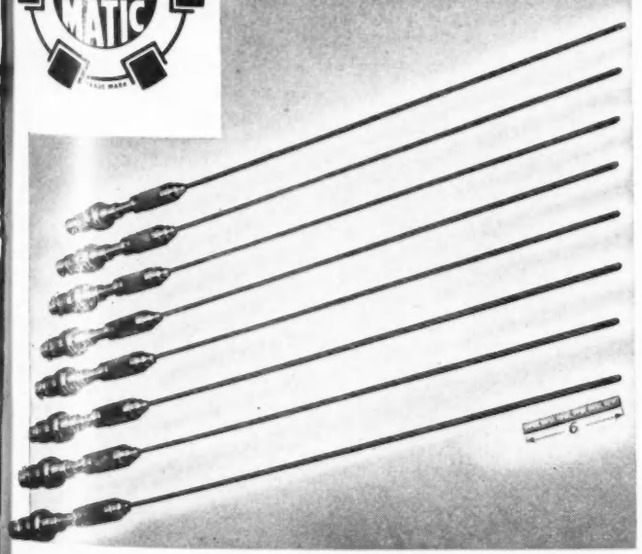
Microhoning saves TIME COST—METAL REMOVAL—MANUFACTURING COST—AND IMPROVES PRODUCT QUALITY; which, combined, means more target hits in the tough service of WAR.

Micromatic Hones range from sizes for bores .303" to 25½" in diameter—from ¼" to 900" long. They generate geometrical and dimensional accuracy, uniform size and any desired surface finish with minimum removal of stock.

MICROMATIC HONE CORPORATION
8100 SCHOOLCRAFT AVENUE, DETROIT, MICH.

ORDNANCE•••—

ORDNANCE•••—
Rifle barrel Microhones for .303" bore have speeded and improved precision rifle making throughout the allied nations.



DIESEL•••—

The use of Microhoning is expanding rapidly. Let us send you literature on latest developments.

Homo-carburizing gears in a machine plant

CARBURIZING THE *New* ALLOYS?
Homocarb's 4-Factor Control Will Help

The fine results being secured with the new low-alloy steels are, of course, largely due to successful heat-treatment; and, at ..... Machine Co., ... Gear Works and perhaps a hundred other plants, this heat-treatment consists largely of Homocarb Method Carburizing. For this method gives the consistently close control of carburizing, which is increasingly needed as the percentages of alloying metals are reduced. It regulates four important factors:

1. Quality of Carbon Source. The Homocarb Fluid which cracks in the furnace to supply the work with carbon is in itself a metallurgical achievement, worked out to provide the best carbon supply, and lab-controlled to assure purity. The Homo convection-forcing fan (another achievement) pushes this gas into every part of the furnace load, so that carburizing action is uniform throughout.

2. Supply of Carbon Source. A precise injector-pump automatically feeds the desired amount of Homocarb Fluid into the furnace, so that carbon supply can be exactly what the job requires.

3. Time of Carburizing. The equipment's Micromax Controller records the length of time, so that this factor can be exactly regulated.

4. Temperature. A Micromax Recording Controller holds the temperature of all parts of the load at the desired point, with no over-shooting and no falling away. Its detailed record shows the heating rate, the temperature and duration of soak, and the time of removal from furnace. Records are permanent and easy to file. Analyzed in the light of results, they end uncertainty.

With these 4 factors under complete coordinated control, the heat-treater has a precision tool for carburizing. The Homocarb does its share; the workers do theirs; and together they save time, space, work and rejects. For further information, see our Catalog T-623, or put your problem directly up to us.

Typical Homo-Carburized parts for machine tools

Jrl Ad T-623(13)

ARMY E NAVY *depends on me!*

LEEDS & NORTHRUP COMPANY, 4966 STENTON AVE., PHILA., PA.

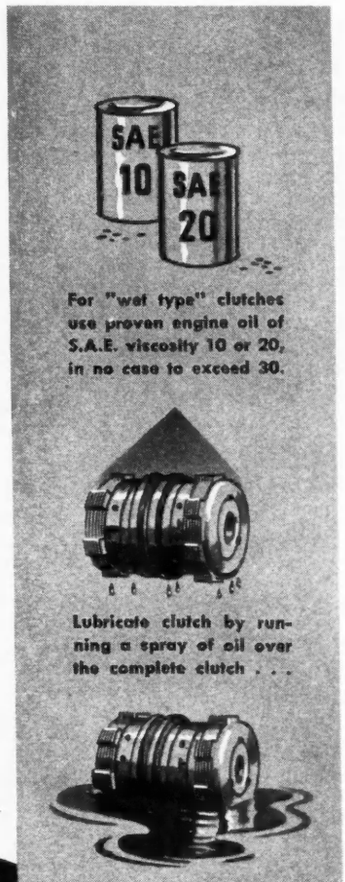
LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

"Keep 'Em Cutting"

This is the Victory slogan of every worker in the Vanadium-Alloys Plants . . . our tool steels are doing their bit on the production firing lines of America . . . cutting, forming and stamping weapons of Victory for the United Nations.

Vanadium-Alloys
STEEL CO., LATROBE, PA.


SAE 10
SAE 20
For "wet type" clutches use proven engine oil of S.A.E. viscosity 10 or 20, in no case to exceed 30.
Lubricate clutch by running a spray of oil over the complete clutch . . .
or by allowing clutch to dip in sump. Dip clutch in no more than 1 inch, nor less than ½ inch of oil.

DON'T USE CUTTING OILS FOR LUBRICATION

These two routine maintenance practices will assure maximum performance and work-life for your Twin Disc Machine Tool Clutches:

1. Regular lubrication with the correct amount and proper grade of lubricant.

2. Proper adjustment as shown on the instruction plate.

The ideal lubricant for any of the "wet type" Twin Disc Machine Tool Clutches is a proven engine oil, manufactured by a reputable refiner. S.A.E. 10 or 20 is best, but in no case should the viscosity exceed 30.

* *Do not use cutting oils for lubrication.* Most cutting oils develop an acid condition which is very harmful to the bronze driving plates in the "wet type" Twin Disc Machine Tool Clutches. The acid attacks the bronze and will eventually cause the failure of the bronze plates. TWIN DISC CLUTCH COMPANY, Racine, Wisconsin.

Twin Disc Machine Tool Clutches, single or duplex, to run dry or in oil. Sizes 2½" to 12".

Illustrated at bottom left, MT Single Machine Tool Clutch. At right, MTU Duplex Machine Tool Clutch.

True conservation

OIL SEALS contain only a few ounces of steel but they protect the vital bearings, gears and shafts in tanks, bombers, combat vehicles and other types of mobile military equipment. Without the adequate protection that oil seals afford, these parts would soon fail in field service. Then the combat equipment would have to be laid up for repairs. But battles are not won with mechanized equipment in the repair shop.

The cost of new bearings, gears and shafts to replace those that failed is not only many times that of the oil seals but more important still, these vital parts require a vastly greater tonnage of steel—and steel must be conserved.

The way to conserve and keep fighting equipment in commission is to protect it the economical way, with "Perfect" Oil Seals. These seals exclude moisture, mud and grit—the mortal enemies of mechanical equipment. At the same time the seals retain the lubricant within the mechanism where it is vitally needed.

The automotive industry has depended on "Perfect" Oil Seals for the last fifteen years, and it is still just plain horse sense to give bearings this necessary protection.

★ ★ ★ ★ ★

CHICAGO RAWHIDE MANUFACTURING COMPANY
1310 ELSTON AVENUE CHICAGO
64 Years Manufacturing Quality Mechanical Leathe
Exclusively and now Sirvene Synthetic Produ
PHILADELPHIA • CLEVELAND • NEW YORK • DETROIT • BOSTON •

Years before

Daily Executive Sessions of this Lake Erie War Production Board expedite all phases of production. Left to right around desk are: O. Hoffman, Chief Engineer; John Doty, Plant Superintendent; C. S. Davis, Jr., Production Promotion; Robert E. Dillon, President and General Manager; H. D. Tweatt, Sales Manager.

LAKE ERIE
ENGINEERING CORP.
BUFFALO, N.Y. U.S.A.

The demands of wartime aviation insure better peacetime performance

McQUAY-NORRIS

ALTINIZED

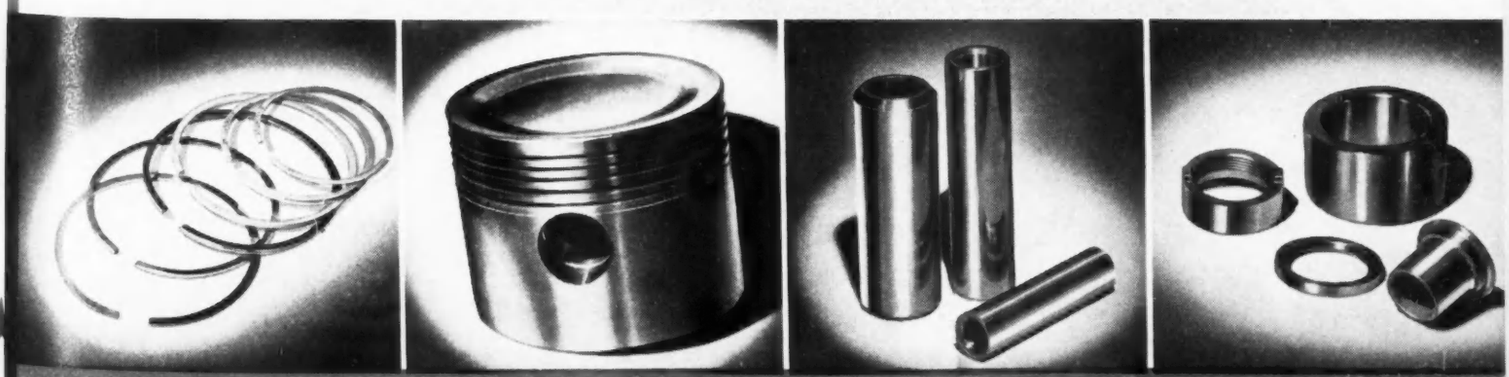
PISTON RINGS

PISTONS . . PINS . .

HARDENED & GROUND PARTS

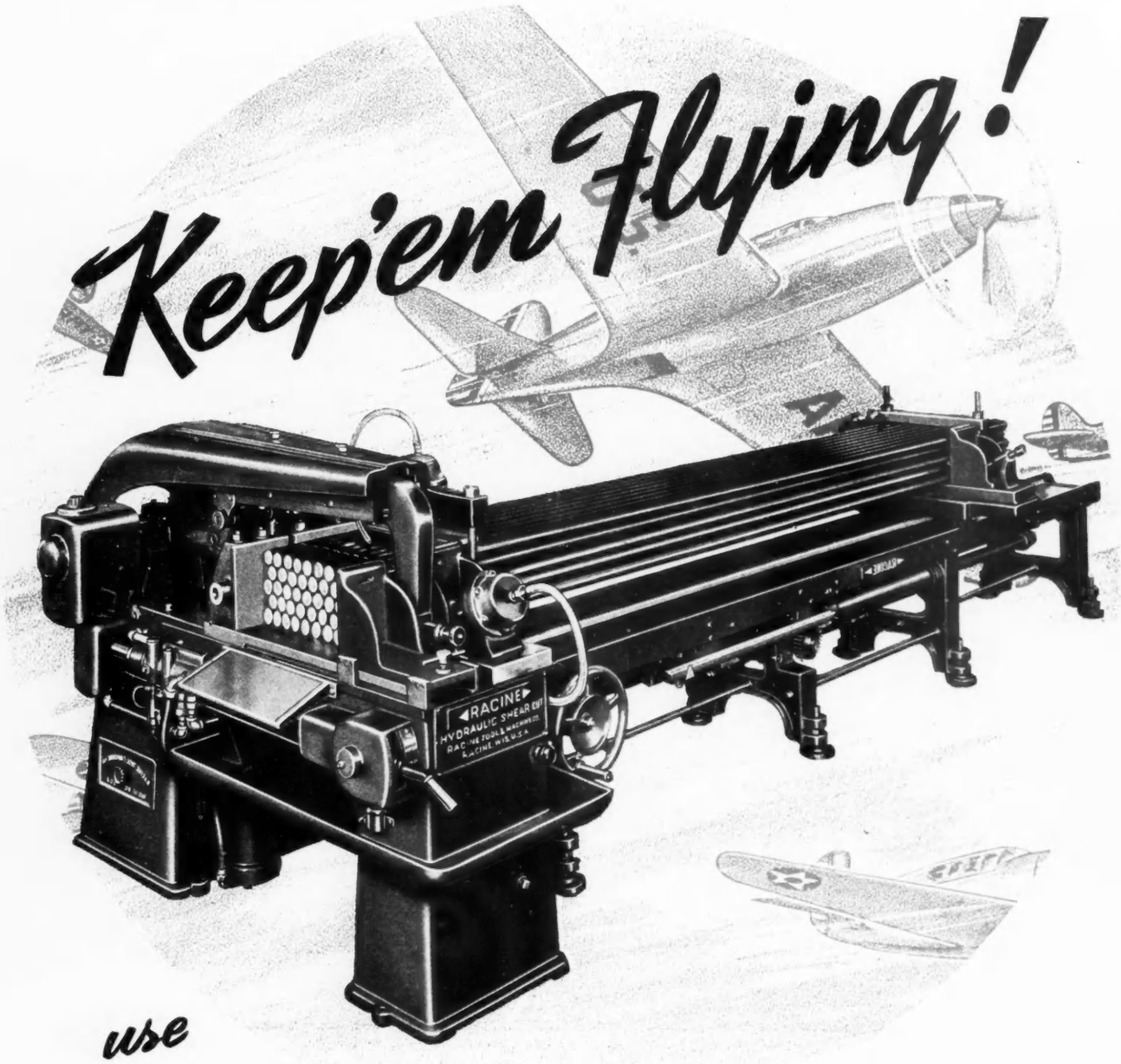
War demands new and higher standards of performance and stamina in aviation parts. McQuay-Norris with a third of a century experience in making automotive precision parts is now extending its services to the aviation industry in increasing measure. McQuay-Norris' policy of clinical research is carried out by our Aircraft Division which offers the industry various precision parts, technical assistance and research experience. Your inquiries are invited.

PRECISION WORKERS IN IRON, STEEL, ALUMINUM, BRONZE, MAGNESIUM



McQUAY-NORRIS MFG. CO. (AIRCRAFT DIVISION), ST. LOUIS, U. S. A.

Keep 'em Flying!



use

RACINE HIGH SPEED SHEAR-CUT SAWS

Over 6,000 pounds of compact sawing machinery—designed and armored to cut the heaviest loads and toughest alloys twenty-four hours a day—are represented in RACINE Heavy Duty Hydraulic Saws with automatic bar feed. Made in four different capacities, 10″x10″, 12″x12″, 10″x16″ and 12″x16″, they easily handle bars in any standard length and loads up to 4,000 pounds.

This is real automatic sawing! Identical pieces from long bars and tubes are hydraulically measured and cut off in any desired length from 1/64″ to 54″. Setting a single pointer on a graduated scale gives you accurate cut lengths and the setting of a graduated dial gives you the correct cutting feed for the size of bundle and type of material being cut. There is no guesswork. Your material is smoothly, quickly handled—cut off by positive oil-cushioned hydraulic power. Simple rugged fool-proof design that inexperienced hands can operate and maintain highest production standards.

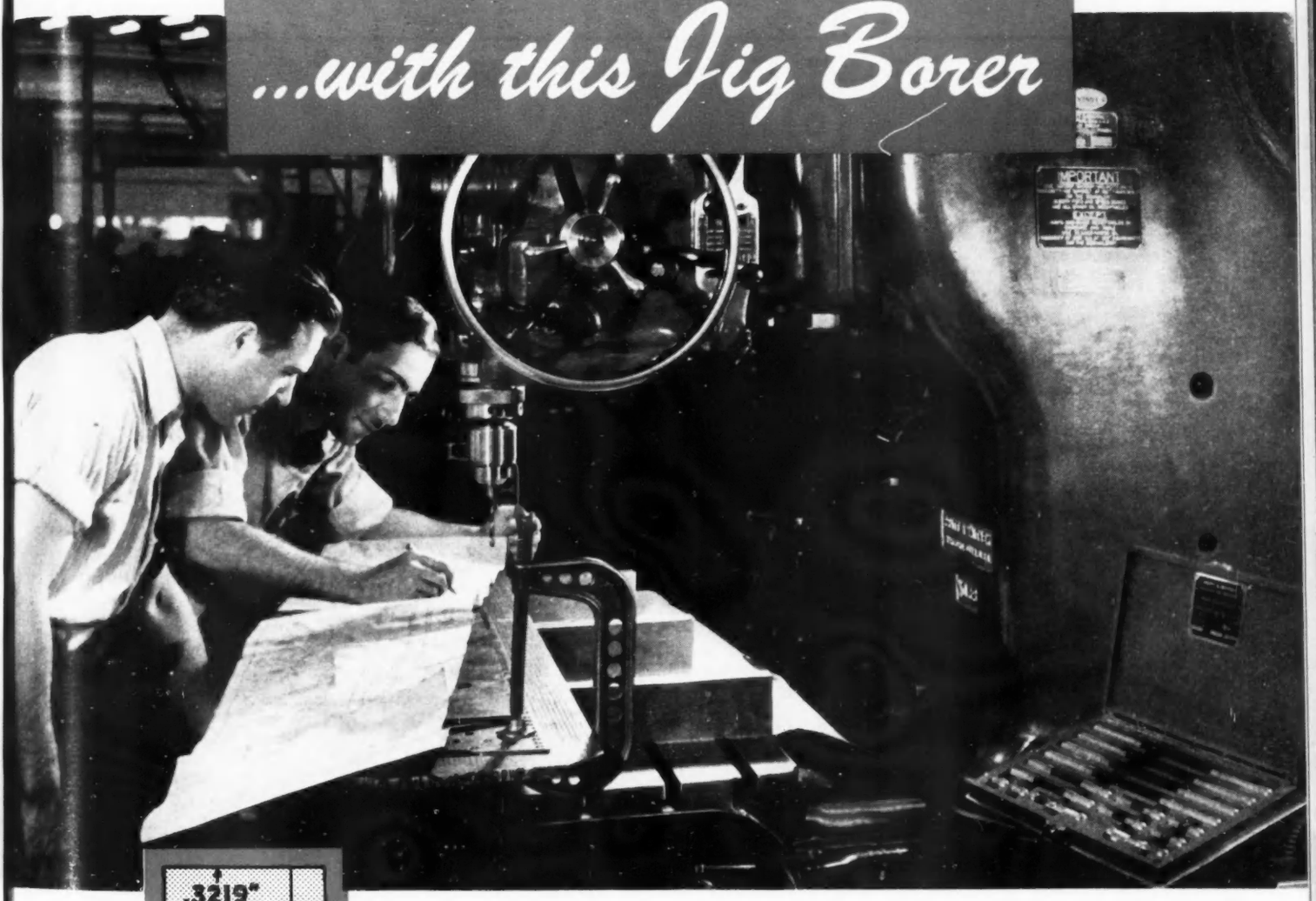
Write today for catalog No. 80-B or for information on any of RACINE'S full line of modern metal cutting saws—from general purpose utility type machines in 6″x6″ capacity to production models in 6″x6″ to 14″x20″.

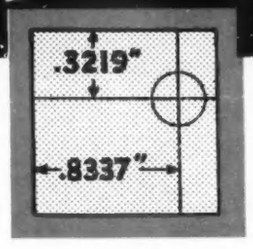
STANDARD THE WORLD OVER

RACINE TOOL MACHINE CO.
1005 CARLISLE AVE. ··· RACINE, WIS.

You could bore at any one of 100 million points in a square inch

...with this Jig Borer





TO make sure you have available all the precision you *do* want, Pratt & Whitney builds into this jig borer a degree of accuracy you'll probably seldom need.

Let's say you're making a jig, and want to bore a hole at a known point. With the P&W Jig Borer, you *could* work to *four decimal places* . . . take your choice of 100 million points in any square inch . . . not just on paper, but *right in the cold metal itself* . . . if you control such variables as temperature and tool wear.

The P&W Jig Borer is one of many Pratt & Whitney products that provide *basic accuracy for mass production*. It can split the linear inch into 10,000 equal parts. It locates, bores, and then checks its own work. From the operator's standpoint, the most important guarantee of accuracy is the pair of dial indicators; once zeroed to a given position, these show at a glance any change from original setting . . . at any stage of the job. Results: speed, precision, less spoilage.

You may seldom work to the last "tenth." But for sure, dependable *basic accuracy* under all working conditions you'll be wise to invest in this *real* jig borer that imposes no limit on your precision.

Call on Pratt & Whitney. Details of P&W Jig Borers will be supplied on request.

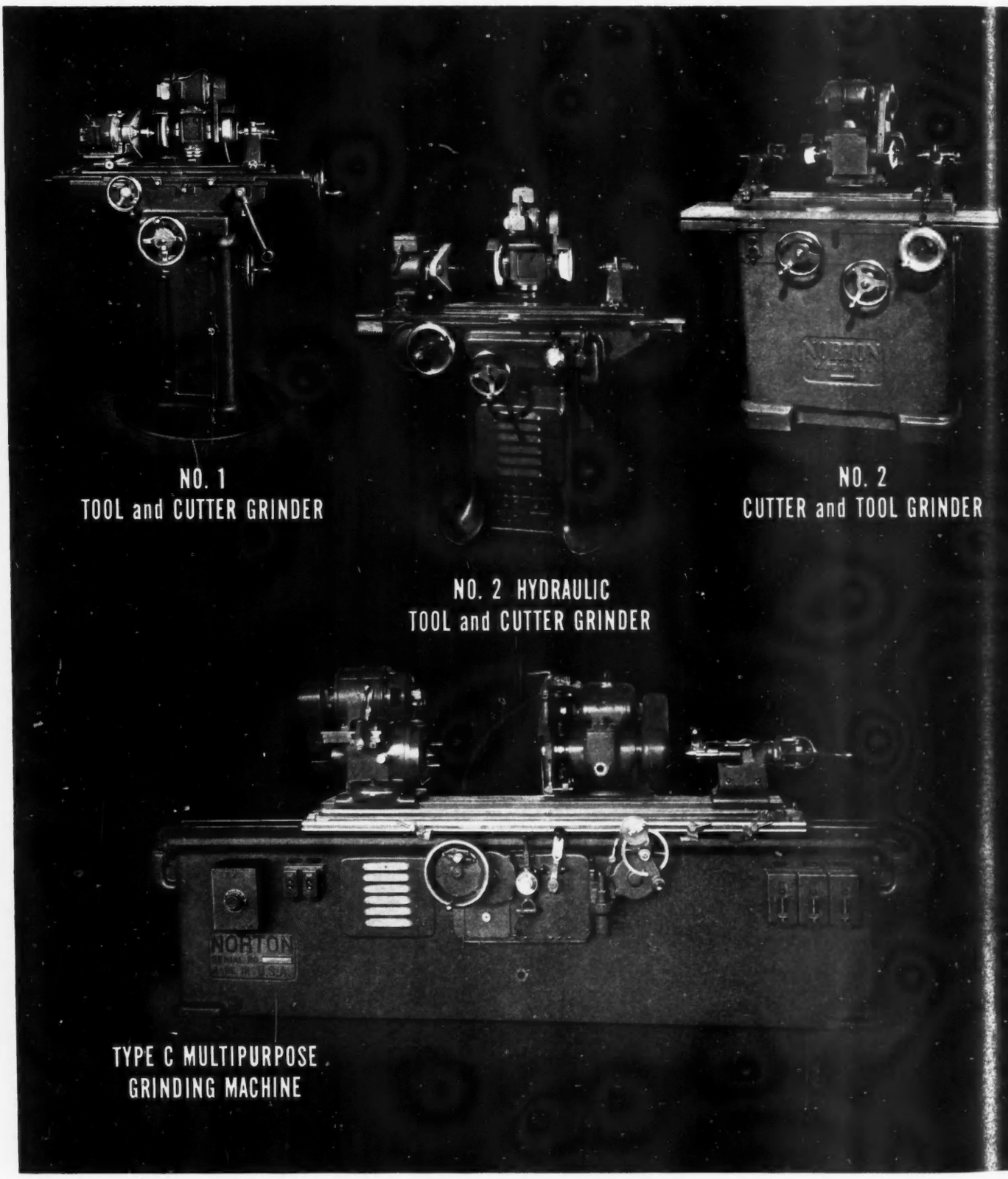
PRATT & WHITNEY

Division Niles-Bement-Pond Company

WEST HARTFORD • CONNECTICUT

For Busy War Plant Tool Departments . . . S

Why not pee



NO. 1
TOOL and CUTTER GRINDER

NO. 2 HYDRAULIC
TOOL and CUTTER GRINDER

NO. 2
CUTTER and TOOL GRINDER

TYPE C MULTIPURPOSE
GRINDING MACHINE

SIX NORTON MACHINES

peed production in your tool room too—by installing more of the more efficient machines

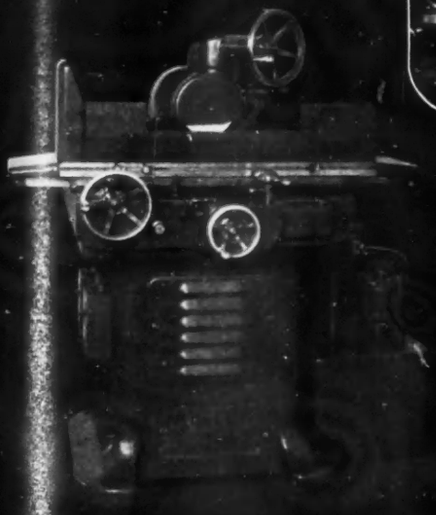
INACCURATE and dull tools cause a waste of time and effort which has no place in the war program.

Valuable hours of toolmaker's time and additional hours in machining parts for the assembly line can be saved if tool rooms are equipped to make tools efficiently and maintain tools so that they can do their work at top speed all the time.

Norton machines for the tool room are accurate and dependable and help maintain quality tools to keep production at its peak.

Catalogs on any or all of these machines on request—no obligation.

NORTON COMPANY
WORCESTER, MASS.

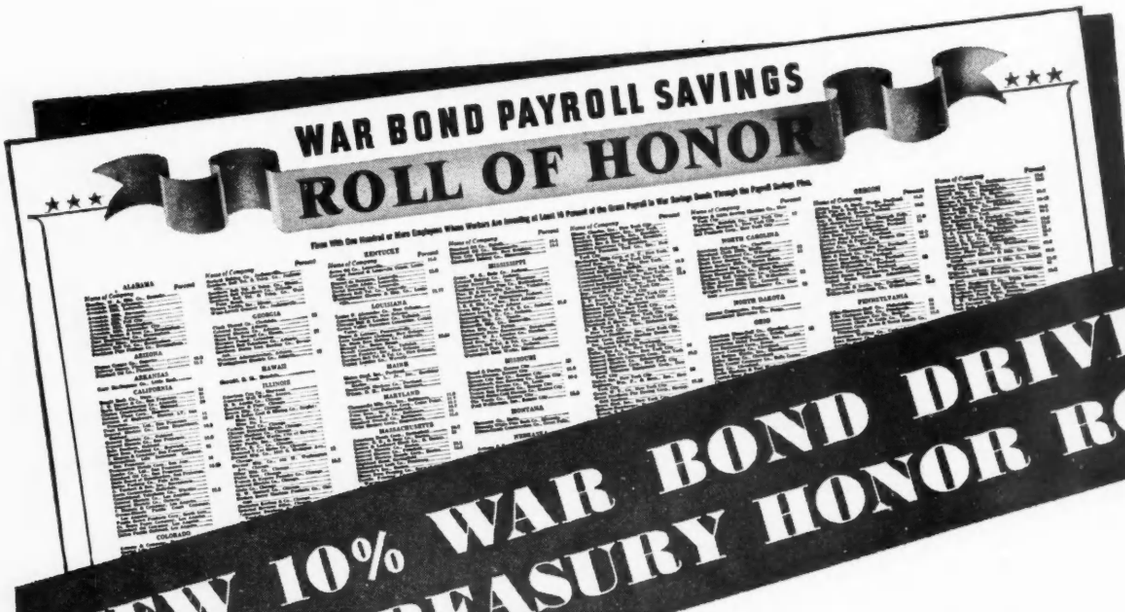


6"x18" HYDRAULIC SURFACE GRINDER

NO. 10-U LAPPING MACHINE

NORTON MACHINES

M-449A



The eyes of all America are upon the United States Treasury Roll of Honor appearing in the "Payroll Savings News." For copy write War Savings Staff, Treasury Department, Washington, D. C.

NEW 10% WAR BOND DRIVES SWELL TREASURY HONOR ROLL

HOW TO "TOP THAT 10% BY NEW YEAR'S"

Out of the 13 labor-management conferences sponsored by the National Committee for Payroll Savings and conducted by the Treasury Department throughout the Nation has come this formula for reaching the 10% of gross payroll War Bond objective:

1. ***Decide to get 10%.***
   It has been the Treasury experience wherever management and labor have gotten together and decided the job could be done, the job was done.
2. ***Get a committee of labor and management to work out details for solicitation.***
   a. They, in turn, will appoint captain-leaders or chairmen who will be responsible for actual solicitation of no more than 10 workers.
   b. A card should be prepared for each and every worker with his name on it.
   c. An estimate should be made of the possible amount each worker can set aside so that an "over-all" of 10% is achieved. Some may not be able to set aside 10%, others can save more.
3. ***Set aside a date to start the drive.***
4. ***There should be little or no time between the announcement of the drive and the drive itself.***
   The drive should last not over 1 week.
5. The opening of the drive may be through a talk, a rally, or just a plain announcement in each department.
6. Schedule competition between departments; show progress charts daily.
7. Set as a goal the Treasury flag with a "T."

As of today, more than 20,000 firms of all sizes have reached the "Honor Roll" goal of at least 10% of the gross payroll in War Bonds. This is a glorious testimony to the voluntary American way of facing emergencies.

But there is still more to be done. By January 1st, 1943, the Treasury hopes to raise participation from the present total of around 20,000,000 employees investing an average of 8% of earnings to over 30,000,000 investing an average of at least 10% of earnings in War Bonds.

You are urged to set your own sights accordingly and to do all in your power to start the new year on the Roll of Honor, to give War Bonds for bonuses, and to purchase up to the limit, both personally and as a company, of Series F and G Bonds. (Remember that the new limitation of purchases of F and G Bonds in any one calendar year has been increased from $50,000 to $100,000.)

TIME IS SHORT. Our country is counting on you to—

"TOP THAT 10% BY NEW YEAR'S"

EVERYBODY EVERY PAYDAY AT LEAST 10%

Save with
War Savings Bonds

Speed

Accuracy

Low In Cost

HONE TO VICTORY

Super-Smooth Finish

Inexpensive to Operate

With THE SUNNEN PRECISION HONING MACHINE

SPEED **to meet today's ever-increasing demand for vital implements of mechanized war.**

ACCURACY **to insure fewer rejects and absolute interchangeability of parts. Super-smooth finish.**

LOW COST **— Both initial and operating.**

WIDE RANGE **— Handles any internal diameter from .185" to 2.400".**

EASY TO OPERATE **— Workers in "teens" — even girls — can be trained to do expert work in a few hours.**

CONSERVES **— Relieves big internal grinders for other jobs. No fixtures needed — work held in hand.**

These are only a few of the reasons why it will pay you to put Sunnen honing to work in *your* plant — as it has hundreds of leading manufacturers.

Aluminum Aircraft Link "produces high finish without bell-mouthing."

Inner Bearing Ring "Accurately removes last 'tenth' of stock."

"Strict alignment maintained between two holes."

Drawing and Blanking Die "Saves time in producing smooth base metal finish."

Bronze Valve. The Sunnen method of honing is used to secure a high finish and accuracy.

Cones for Wheel Balancing Machine "Accurately align hones two interrupted surfaces."

Saved time in producing a smooth, accurate finish on this bronze remote control valve body.

Aviation Hydraulic Cylinder made of Aluminum-Alloy. Improves the quality of the bearing surface. An extremely smooth surface-finish is secured.

Diesel Engine Fuel Injector Cylinder "So accurate that a piston can be fit within .00005 inch."

Aircraft Valve Tappet Roller. 4-Micro finish.

Hardened Steel Inner Bearing Race honed to .00005" limit. Surface finish improved; errors of out-of-roundness eliminated.

Drill Jig Bushing "Increases sales appeal of product."

SUNNEN

Write for FREE BULLETIN

giving complete information or, if you prefer, a Sales Engineer will be glad to call with his demonstrator and show you what this machine can do on your job.

SUNNEN PRODUCTS CO., 7915 Manchester Ave., St. Louis, Mo.

Canadian Factory: Chatham, Ontario

Cut down on bearing failures and prevent delays in producing war orders

You can automatically lubricate every bearing on a machine with a LINCOLN CENTRO-MATIC LUBRICATING SYSTEM

Speed-up war production with the aid of a Lincoln Centro-Matic Lubricating System . . . Easily installed on new or old machines, and makes it possible to lubricate all bearings from a single source . . . Permits machines to run 7 days and 7 nights a week without taking time out for lubrication service.

A Centro-Matic System consists of a number of Centro-Matic Injectors—one for each bearing—and a hand operated or a power operated Centro-Matic Lubricant Pump. A power operated system can be semi-automatic or it can be full automatic. The injectors can be grouped in manifold or located separately at each bearing. In either arrangement only a single lubricant supply line is required.

Send for COPY of BULLETIN 888

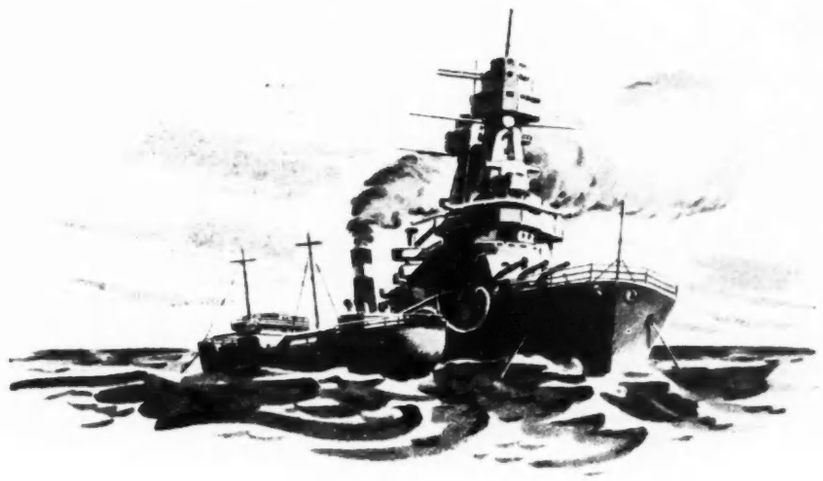
—or send us specifications on the machinery to be lubricated, and our engineers will gladly make recommendations. No obligations.

ARMY-NAVY PRODUCTION AWARD for high achievement in the production of war equipment has been conferred upon the Lincoln Engineering Company. It serves as inspiration toward greater and greater accomplishment until the time of final and complete Victory.

LINCOLN ENGINEERING COMPANY

Pioneer Builders of Engineered Lubricating Equipment

ST. LOUIS, MO., U. S. A.



How to Feed a Battleship!

TODAY, battleships refuel and get back on the job faster . . . hundreds of cargo ships are "turning around" in port more quickly because, several years ago, Thiokol* synthetic rubber supplied the key to constructing smooth-bore, oil-loading hose. In this hose America's pioneer synthetic is used as the silk-smooth inner liner which eliminates turbulence, cuts friction between oil and hose to the bone. The rate-of-flow through hose with a Thiokol liner is much higher than with the older types.

Thiokol synthetic rubbers have improved oil-loading hose in many other ways. Previous types necessarily embodied oil-vulnerable, natural rubber liner reenforced with heavy metal bands. The use of flexible, oil-proof Thiokol synthetic rubber removed these disadvantages, decreased weight, increased ease of handling and provided a far longer hose life.

An engineering material proved many years before Pearl Harbor, Thiokol synthetic rubber is helping us wage successful war on land, sea and in the air. Much new technical data on forms and applications of this synthetic have been amassed by our research and development staff. If your work is war work, ask for it.

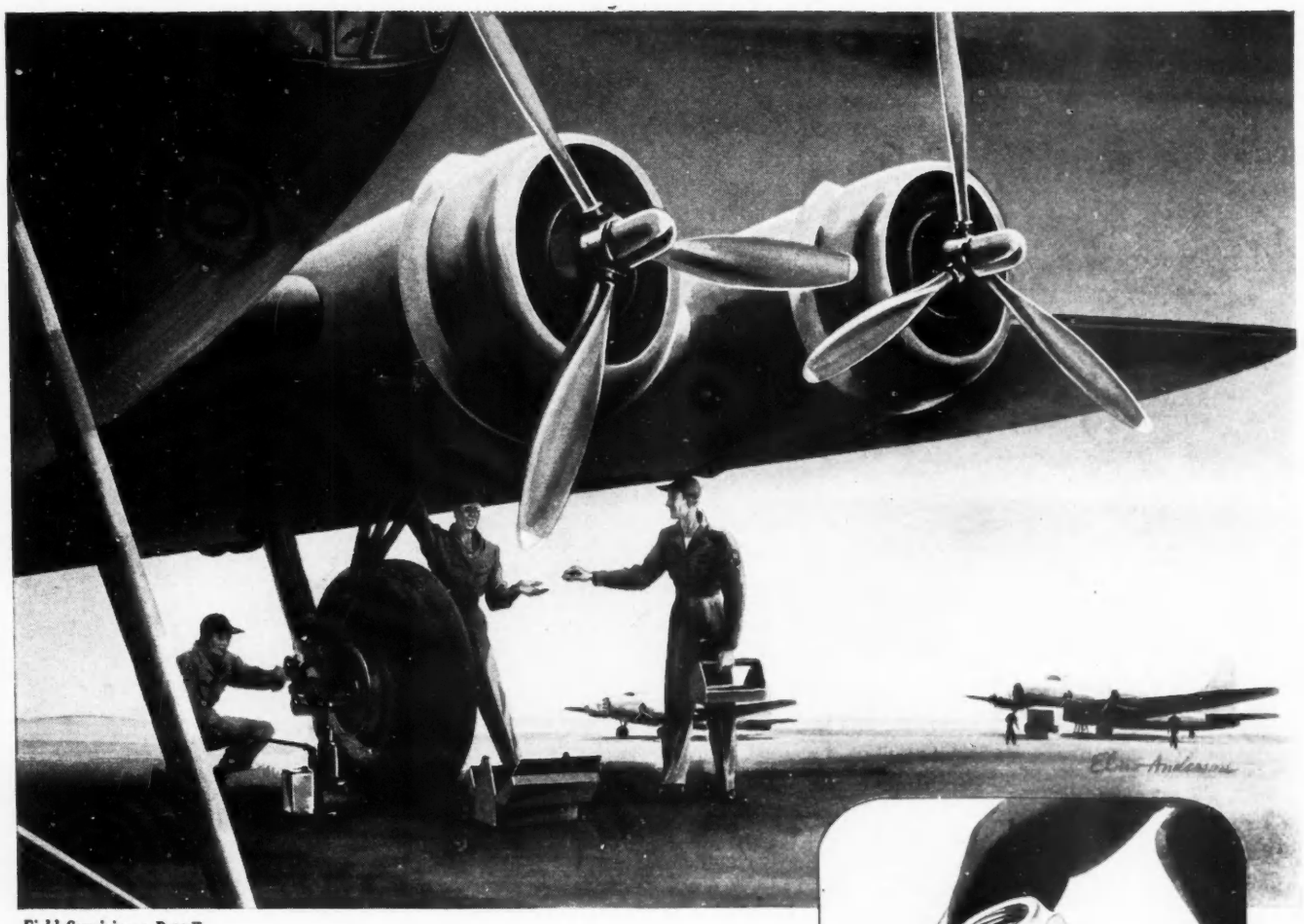
Thiokol Corporation, Trenton, New Jersey

Thiokol*

SYNTHETIC RUBBER

"America's First"

*Thiokol Corporation trade-mark, Reg. U. S. Pat. Off.



Field-Servicing a B-17E

"THE LIEUTENANT WILL BE GLAD TO KNOW"...

Any pilot is glad to know that the ship he flies is protected with Boots all-metal, self-locking nuts. That knowledge gives him an added sense of security, because Boots Nuts are safer; even the severest vibration cannot jar them loose. They are unaffected by the corrosive action of oil, chemicals, or weather. Their resistance to high temperatures is almost phenomenal. In fact, they literally "outlast the plane."

Not only that, but, because they are more easily applied, they cut down the time a plane must spend on the ground for maintenance and repairs. And, of course, that means more *fighting* time, which is the most important consideration of all.

On every battle front in the world, on every type and 'most every make of plane, these ingenious fastening devices are contributing to the striking power of our Air Force.

It's Self-locking

The Boots principle of self-locking as employed in the Bellows, Wing, and Rol-Top (illustrated above) styles are well-known throughout the aircraft industry. In each case the nut is one-piece, all-metal. The self-locking action is obtained by means of the out-of-phase locking collar connected to the lead threads by means of a resilient spring member.

Here are a few of the planes fabricated with Boots Nuts:

Grumman Wildcat F4F-3
Boeing Flying Fortress B-17
North American B-25
Curtiss Commando C-46
Consolidated Liberator B-24E
Curtiss P-40
Curtiss Dive Bomber SB2C-1
Edo Floats
Plywood Planes
Brewster Buccaneer

BOOTS

Self-Locking Nuts For Application In All Industries

BOOTS AIRCRAFT NUT CORPORATION ★ GENERAL OFFICES, NEW CANAAN, CONNECTICUT

WALKER-TURNER FLEXIBLE SHAFTING

...meets war's hardest tests!

In aircraft and other mechanical weapons — where requirements are unusually severe — Walker-Turner Flexible Shafting has thoroughly demonstrated exceptionally high quality of design and materials. As one of the largest manufacturers of flexible shafting for industry, Walker-Turner has gained wide experience in design, production and application of flexible shafting for remote control and power transmission.

Although it is one of the busiest departments of this Company, we are always glad to help other concerns who may wish to learn more regarding the possibility of simplifying design through the use of flexible shafting. Walker-Turner Flexible Shafting is available today in products used for war purposes, in a wide range of sizes and specifications.

WALKER-TURNER COMPANY, INC.
Berckman Street Plainfield. N. J.

walker-turner
COMPANY, INC.
PLAINFIELD, N.J.
U.S.A.

FLEXIBLE SHAFTING

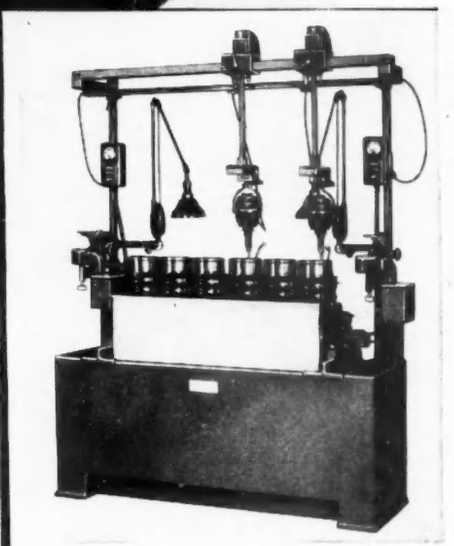
FOR REMOTE CONTROL AND POWER TRANSMISSION

"WITH" HALL AERO VALVE SERVICING EQUIPMENT

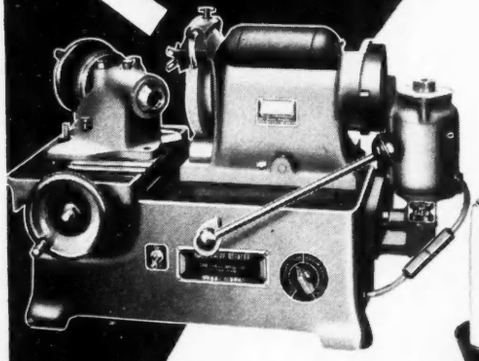
MORE MEN IN THE AIR

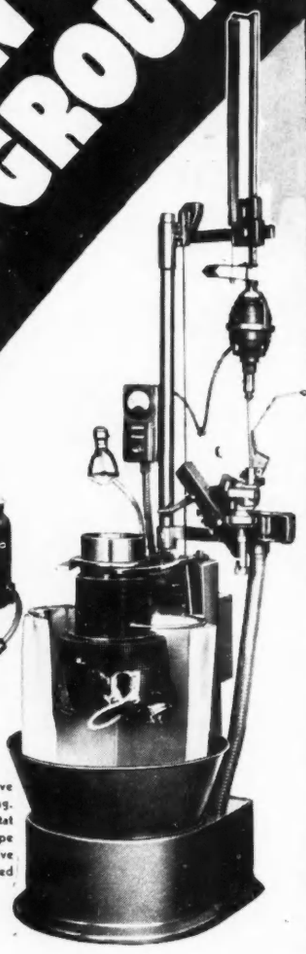
CAN KEEP

FEWER MEN ON THE GROUND



Above: HALL Model AWA (Allison type) ECCENTRIC Wet Type Valve Seat Grinder in use in in-line cylinders. Readily adaptable to maintenance of seats in radial engines also.





Above: HALL Model 80A Wet Type Valve Refacer designed expressly for aero valve refacing. Has dual motors, micrometer feed and rheostat control. At right: AW ECCENTRIC Wet Type Valve Seat Grinder for "blind" grinding of valve seats in radial type aero engines. Widely adopted for both production and service.

By duplicating original factory standards of precision and finish quickly—by permitting any ordinary mechanic to "blind" grind valve seats and valve faces accurately without time lost in repeated gauging operations—by making valve overhauls unnecessary for hundreds of extra flying hours, HALL Aero Valve Servicing Equipment actually keeps more men in the air with fewer men on the ground.

Under present conditions, this is extremely important in both military and commercial use.

That's why we're working day-and-night shifts to supply the demand for HALL Aero Valve Servicing Equipment.

If you would like to have all the details of HALL ECCENTRIC Valve Seat Grinding and Wet Valve Refacing, write or wire us today.

THE HALL MANUFACTURING CO.
TOLEDO, OHIO, U. S. A.

Photo by U. S. Army Signal Corps

Mallory Helps Our "Hell Buggies" Kiss The Noise Good-Bye!

Communication between commanders and single units of an attacking column must not be "muddied" by the staccato zip-zip-zip of spark-plugs, electric motors, inverters or other man-made static within the zone of operations. So Mallory Noise Filters step in to suppress static and assure the clear communications that may mean the difference between success and failure . . . life or death.

On battlefronts in the air, on the sea and under the sea, Mallory Noise Filters are equally important . . . helping our fighters kiss the noise good-bye! On the home front, too, where clear radio reception is vital to Civilian Defense . . . and where static might guide enemy bombers to American targets, as has already occurred in Allied countries . . . Mallory Noise Filters help "keep 'em listening" in safety.

Noise filters, however, are just one of the many Mallory Approved Precision Products now serving in both military and industrial applications. Condensers, rectifiers, Rectostarters, rheostats, volume controls, switches, jacks and plugs, vibrators and Vibrapacks . . . these and other Mallory parts are doing a job where conditions are toughest.

If you need electronic parts . . . for laboratory or test work, for replacements in existing equipment, or as elements in some new device . . . call on your nearest Mallory Distributor. There are 253 Mallory Distributors from coast to coast, ready to serve you promptly. Ask your Mallory Distributor, too, for your free copy of the latest Mallory Catalog . . . used as a buying guide in the aeronautical, automotive, electrical, geophysical, radio and other essential industries.

Write today for your Mallory Distributor's name, and for your copy of this useful catalog.

P. R. MALLORY & CO. Inc.
MALLORY
APPROVED
PRECISION PRODUCTS

P. R. MALLORY & CO., Inc. INDIANAPOLIS, INDIANA • Cable Address—PELMALLO

KEEP THIS EGG WARM . . . IF YOU WANT IT TO HATCH

Maintain your hard-won contacts and keep your name and brand alive in Latin-America, our most accessible and promising post-war market, by advertising NOW in *B.P.I.C. Specialized Export Publications. Write for brochure "What the Export Advertisers Are Saying". No cost, no obligation.

*BUSINESS PUBLISHERS INTERNATIONAL CORPORATION

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330 WEST 42nd STREET, NEW YORK CITY

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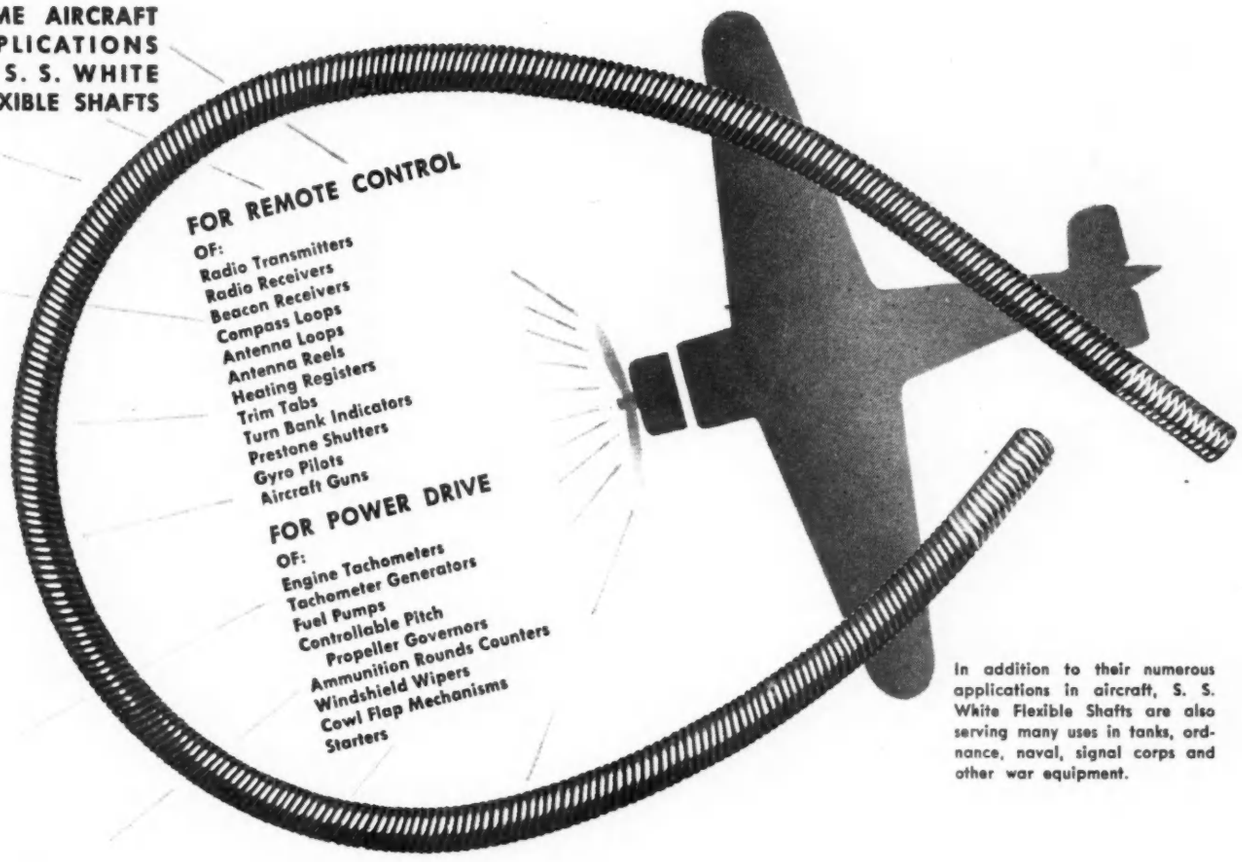
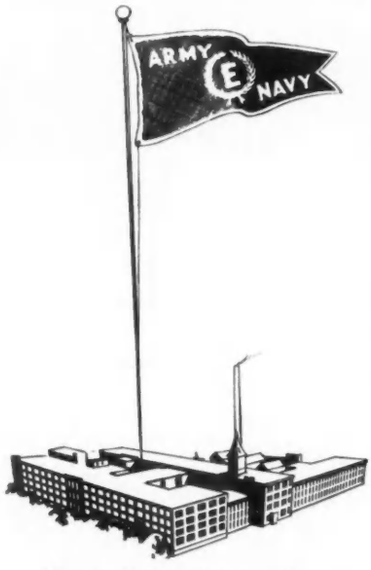
SOME AIRCRAFT APPLICATIONS OF S. S. WHITE FLEXIBLE SHAFTS



In addition to their numerous applications in aircraft, S. S. White Flexible Shafts are also serving many uses in tanks, ordnance, naval, signal corps and other war equipment.

On anything pertaining to FLEXIBLE SHAFTS *—S. S. White can help you*



Proudly it flies—the Army-Navy "E" flag awarded to our Staten Island plant where Industrial Division products are made. They say it with PRODUCTION.

Whether you need flexible shafts for an established use—or are working out an entirely new application—S. S. White can help you.

With 50 years' experience, we have the business of making flexible shafts thoroughly organized. We've been turning out millions of feet annually for peacetime uses. Now we're making them exclusively for war needs—and while the demand is at an all-time high and still growing—we are meeting it. Chances are strong we can give you satisfactory deliveries.

For new applications, S. S. White offers you the largest selection of remote control and power drive flexible shafts, companion casings and end fittings. Also, a wide range of complete units of shaft, casing and fittings already developed for existing uses, among which there is likely to be one that will meet the requirements of your new application—with much saving of time and expense. And you can get your new application worked out faster and better with the aid of our engineers. They are flexible shaft specialists.

On any matter pertaining to flexible shafts, it will pay you to • • • •

Consult S. S. White.

S. S. WHITE

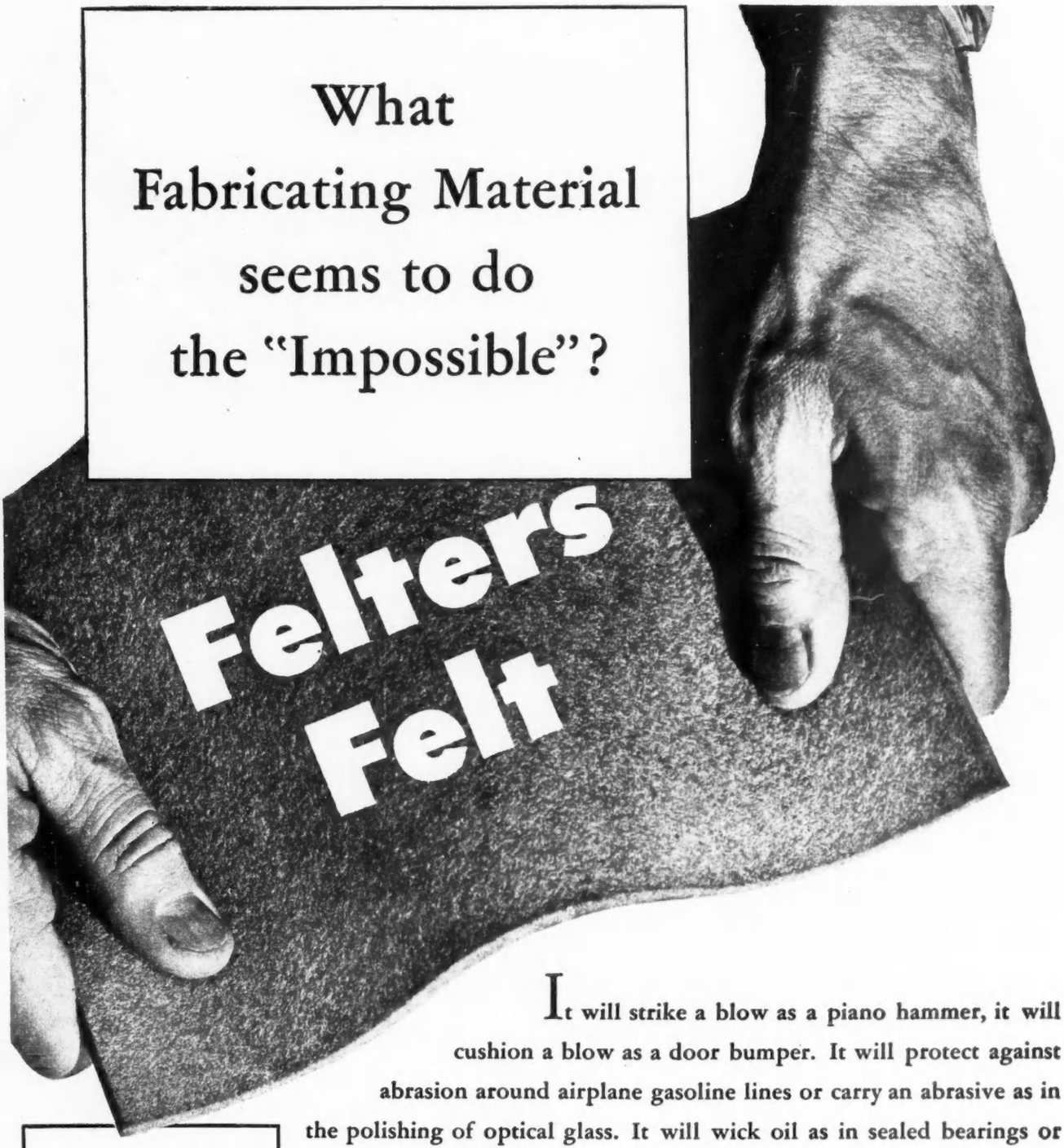
The S. S. White Dental Mfg. Co.

INDUSTRIAL DIVISION

Dept. A, 10 East 40th St., New York, N. Y.

PIONEER AND LEADING MAKER OF FLEXIBLE SHAFTS FOR POWER DRIVES, REMOTE CONTROL AND COUPLING

What Fabricating Material seems to do the "Impossible"?



It will strike a blow as a piano hammer, it will cushion a blow as a door bumper. It will protect against abrasion around airplane gasoline lines or carry an abrasive as in the polishing of optical glass. It will wick oil as in sealed bearings or seal in oil as in automobile rear end assemblies. It can be cut to fit your design because it cuts with a knife, die or shears. You can punch it, perforate it, machine it. You can use it in combination with glass, wood, metal, plastics. You can even treat it *chemically* to meet technical and industrial requirements.

Felters Felt is made up to S.A.E. and Army and Navy specifications. Send specific problems concerning the use of Felt to our Research Laboratory, or ask for our free booklet, "Felt Uses."

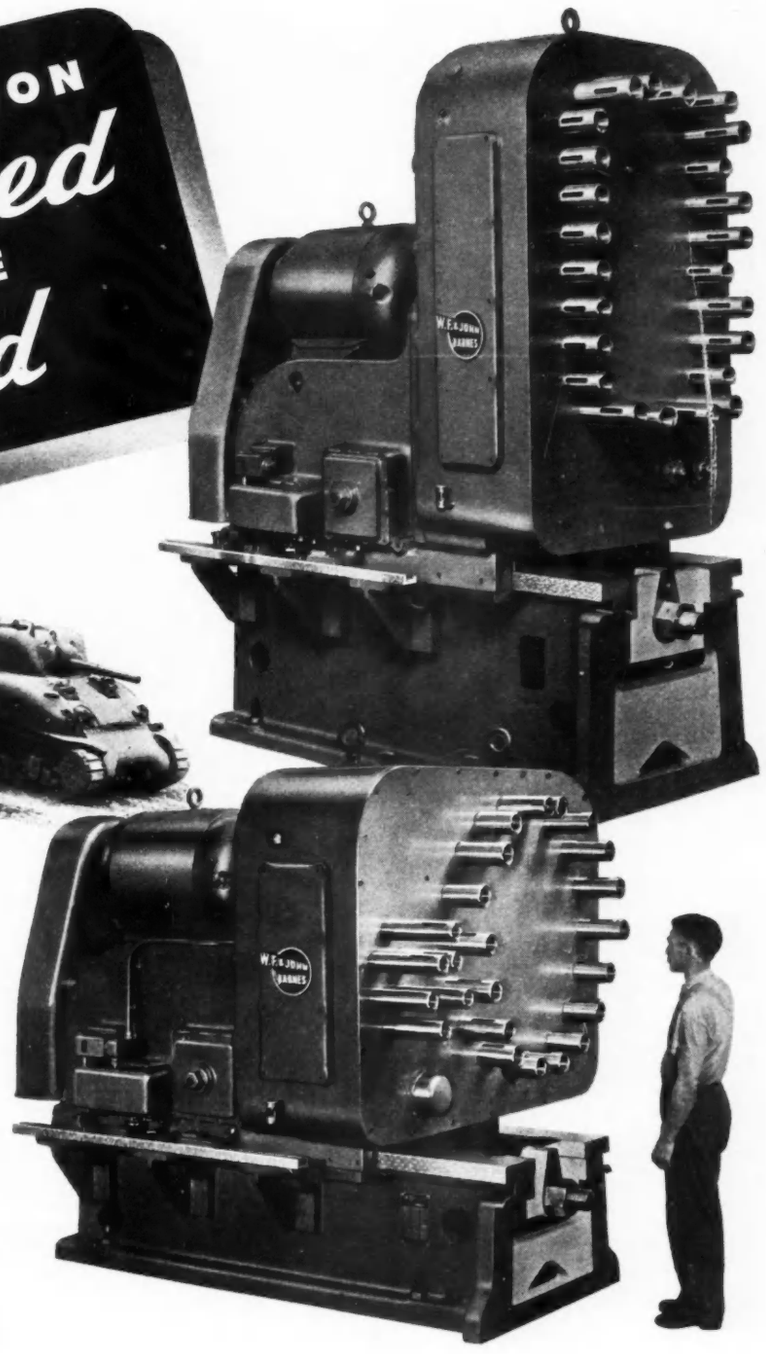
THE Felters Company INCORPORATED

210-Q SOUTH STREET • BOSTON, MASSACHUSETTS

Offices: New York, Philadelphia, Chicago, Detroit • Sales Representatives: Dallas, Los Angeles, Nashville, St. Louis, St. Paul
Mills: Johnson City, New York; Millbury, Massachusetts; Jackson, Michigan

TANK PRODUCTION *Increased* VITAL TIME *Saved*

Photograph from
Press Association, Inc.



Here's How!

W. F. AND JOHN BARNES MULTIPLE-SPINDLE DRILLING UNITS GET TANKS TO THE *FIGHTING FRONTS FASTER!*

★ One of America's greatest offensive weapons is the new M-4 tank with its 360-degree revolving turret. Placed on mass production basis by the Automotive Industry and rolling off the assembly lines, where but a short time ago came our fine cars and trucks — these land battleships are proof to the Axis that America is geared to out-produce them in military equipment.

One half the time required to engineer and build the complete machine for drilling the turret of the M-4 Medium Tank was saved.

Here's How! — The two multiple-spindle drilling units, illustrated, furnished by W. F. and John Barnes were substantially the same as our standard hydraulically-actuated SH-24 units. These two units, being of our standard design, with standard drawings immediately available to the customer, required engineering on the drilling heads only!

The fixtures and the balance of the machine, designed and furnished by the customer, were completed at a time to coincide with the completion of the drilling units.

This is another splendid example of the cooperative effort today of American Industry to speed the production of fighting equipment. One unit having 25 spindles and the other having 24 spindles in clusters of 18 and 6, equally spaced, with hardened alloy steel gears and heat treated spindles, were completely equipped with anti-friction bearings.

Are you using drill presses for your jobs that are better suited to Multiple-Spindle drilling?

FREE *A set of data sheets on W. F. and John Barnes standard hydraulically-actuated units will be sent to you promptly—send for your copies today.*

W. F. & JOHN BARNES

W. F. and JOHN BARNES

312 SOUTH WATER STREET • ROCKFORD, ILLINOIS, U.S.A.

BLAKESLEE

METAL PARTS WASHERS

DEGREASERS

BLACOSOLV DEGREASING SOLVENTS

SPIRAL AND BELT TYPE QUENCHERS

ENGINEERED FOR YOU

FOR perfect cleaning of stampings, punchings, deep draws, machined castings, screw machine products use Blakeslee *engineered-for-you* metal parts washers and degreasers. Blakeslee equipment makes it possible to speed up painting, assembly, plating, finishing, and, after quenching, machining, polishing, forming, etc. Let us make a survey of your plant without obligation and submit proposals to help you speed production. Write for free information.

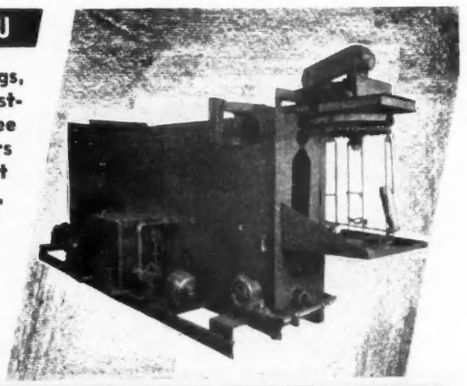


Photo: Blakeslee wash and rinse machine for 105 mm. shells, adaptable for other sized shells.

G. S. BLAKESLEE & CO. MAIN OFFICE & WORKS • CICERO STATION **CHICAGO** NEW YORK • TORONTO

BUYERS' GUIDE

Automotive Products and Factory Equipment Manufactured by Advertisers in This Issue

See Alphabetical List of Advertisers on page 118

This Buyers' Guide is published as a convenience, and not as part of the advertising contract. Every care will be taken to index correctly. No allowance will be made for errors or failure to insert

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Aluminum Co. of America
Carnegie-Illinois Steel Corp., U. S. Steel Corp. Subsidiary
Climax Molybdenum Co.
Republic Steel Corp.

Ferro
Vanadium Corp. of America

Non-Ferrous
Dow Chemical Co.
Mallory & Co., Inc., P. R.

Analyzers

Combustion
Electro Products Laboratories

Bearings

Ball
Ahlberg Bearing Mfg. Co.

Brass, Bronze, Sleeve
Johnson Bronze Co.

Roller
Ahlberg Bearing Mfg. Co.

Roller, Tapered
Hyatt Bearings Div. Gen. Motors Corp.
Timken Roller Bearings Co.

Self Lubricating
Johnson Bronze Co.

Blue

Mechanics
Permatex Co., Inc.

Bolts

Progressive Mfg. Co., The
Republic Steel Corp.

Broaches

National Broach & Machine Co.

Carriers

Storage Battery
Central Equipment Co.

Castings

Aluminum & Brass
Aluminum Co. of America
Judd Co., Inc., H. L.

Steel
Carnegie-Illinois Steel Corp., U. S. Steel Corp. Subsidiary

Cement

Cast Iron & Pipe Joint
Permatex Co., Inc.

Centers

Bench
Barber-Colman Co.

Channels for Glass

Felt
American Felt Co.
Felters Co., Inc.

Chemicals

Rohm & Haas Co.

Clamps

Adel Precision Prod. Corp.

Hose
Central Equipment Co.
United Specialties Co.

Cleaners

Air, Oil Bath
United Air Cleaner Div., United Specialties Co.

Metal
Detroit Rex Products Co.

Clips

Fuse (Copper)
Littelfuse, Inc.

Clutches

Industrial
Twin Disc Clutch Co.

Compounds

Cutting Fluid
Petroleum Advisers, Inc.

Finishing, Polishing & Rubbing
McAleer Mfg. Co.

Glazing, Rust Preventing & Valve Grinding
Permatex Co., Inc.

Controls

Dash
Arens Controls, Inc.

Conveyors
Bartlett, C. O., & Snow Co.

Couplings
Hansen Mfg. Co.

Crankshafts
Atlas Drop Forge Co.
Wyman-Gordon Co.

Cups, Leather
Chicago Rawhide Mfg. Co.

Cutters, Gear
Cylinder Head
Central Equipment Co.
Keyseating, Milling & Boring
Barber-Colman Co.

Cylinders
Curtis Pneumatic Machinery Co.

Dies
Berg Engineering Service
Mallory & Co., Inc., P. R.
Sets
Danly Machine Specialties, Inc.
Threading (Automatic)
National Acme Co.

Engines
Waukesha Motor Co.

Fastening Units
Boots Aircraft Nut Corp.
Judd Co., Inc., H. L.

Feeds
Dial for Punch Press
Littell Machine Co., F. J.

Felt
Amercian Felt Co.
Booth Felt Co., Inc.
Felters Co., Inc.

Fittings
Aircraft
Dole Valve Co.

Fixtures
Aircraft
Berg Engineering Service

Forgings
Carnegie-Illinois Steel Corp., U. S. Steel Corp. Subsidiary
Wyman-Gordon Co.
Drop
Atlas Drop Forge Co.

Furnaces
Electric & Fuel Fired
American Bridge Co., U. S. Steel Corp. Subsidiary
Electric Furnace Co., The
Heat Treating
Leeds & Northrup Co.
Lindberg Engineering Co.

Fuses
Electric
Littelfuse, Inc.

Gages, Electric, Gasoline
Inspection or Manufacturing
Sheffield Corp., The

(*Turn to page* 106, *please*)

Small Brass

CASTINGS

to your specifications

FAST DELIVERY . . . ANY QUANTITY

IF YOU need small brass castings in large quantities, thousands or millions . . . if you need them done *right* to your specifications and delivered *when* and *where* you want them . . . then wire Judd, phone Judd, or use the coupon below — for *it's a Judd job.*

Brass castings are only one of many Judd war products. All the Judd metalworking facilities that normally produce the world's finest and most complete line of drapery fixtures and housefurnishing hardware are now in war work. Small metal parts — military hardware — anything that's cast, spun, formed, stamped, threaded, tapped, riveted, plated, or almost anything else — is a Judd job.

Get details . . . use the coupon below. Or wire or phone our New York Office; ask for War Contracts Manager, at WOrth 2-3653.

DO YOU NEED PARTS LIKE THESE TYPICAL JUDD WAR PRODUCTS?

20 Mm. Rotating Bands; "D" Rings; Snaps; Loops; Slides; Buckles; Keepers; Hooks; Clips; Pull Rings (for Artillery Ammunition); Bolts and Nuts (for Small Arms Cases, etc.); Many Small Stamped Parts (replacing Forgings; have your Engineers check with Judd); Base Plugs (for 20 Mm. Shot).

JUDD

Military Hardware

Since 1870

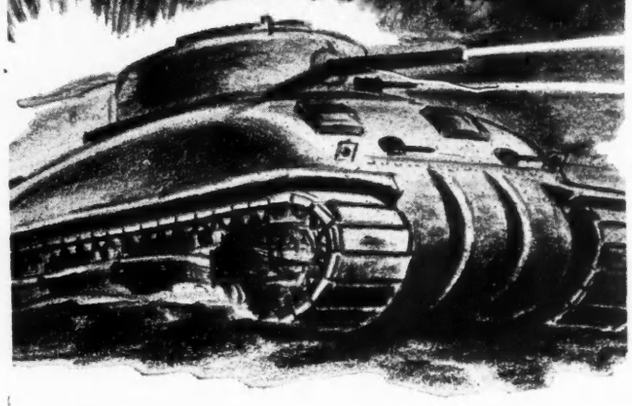
War Contracts Manager, H. L. JUDD COMPANY
87 Chambers Street, New York City. AI-1215

Send me your War Contracts Bulletin.

Name.....

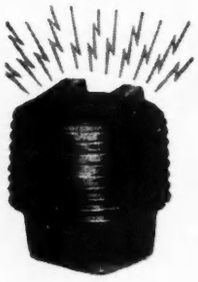
Address.....

Machine guns can't dent it..



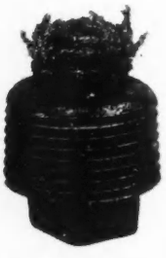
..but tiny steel particles could STOP it!

TOUGH as they are, tanks could be put out of action by the abrasive, grinding action of steel chips and particles in the gear, bearing and engine lubricants. Fortunately, Uncle Sam's battle wagons are practically immune to this kind of damage, because they are now MAGNETIC PLUG-equipped.



Magnetic Drain Plugs contain a powerful permanent magnet which attracts and holds iron and steel particles which are constantly formed by ordinary wear.

Removal of these particles eliminates one of the most common causes of excessive wear.



MAGNETIC PLUGS are now available only for essential war equipment. Limited quantities of samples are available, however, for testing in all types of products. Write for full details and sample offer.

LISLE CORPORATION, Box 1001, Clarinda, Iowa

Magnetic DRAIN PLUGS

BUYERS' GUIDE—(*Continued from page* 105)

Gaskets
Fitzgerald Mfg. Co., The
Cork
Victor Mfg. & Gasket Co.
Fibre
Victor Mfg. & Gasket Co.
Leather
Chicago Rawhide & Mfg. Co.

Grinding Machines
Heald Machine Co.
National Acme Co.
Norton Company
Sunnen Prod. Co.

Heads
Cylinder
Aluminum Co. of America

Heat Treating
Barnes Co., Wallace, Div. of Associated Spring Corp.
Barnes - Gibson - Raymond Div. of Associated Spring Corp.
Gibson Co., Wm. D., Div. of Associated Spring Corp.

Hoists
Curtis Pneumatic Machinery Co.

Hotels
American Hotel Association

Instruments
Testing
Electro Products Laboratories

Jacks
Car Lifting
Spun Steel Corp.

Joints
Universal
Mechanics Universal Joint Div. Borg-Warner Corp.

Lamps
Drying
North American Elec. Lamp Co.

Lathes
Automatic & Turret
Gisholt Machine Co.
Potter & Johnston Machine Co.
Chucking
Potter & Johnston Machine Co.
Wood Turning
Walker-Turner Co., Inc.

Lubricators (Hand)
Central System, Pressure & Portable
Lincoln Engineering Co.

Machines
Balancing
Gisholt Machine Co.
Norton Company
Bar & Chucking
National Acme Co.
Boring
Barnes Co., W. F., & John
Heald Machine Co.
Sunnen Prod. Co.
Cutting, Metal
Racine Tool & Machine Co.
Whitney Metal Tool Co.
Degreasing
Detroit Rex Products Co.
Drilling
Barnes Co., W. F., & John
Rehnberg-Jacobson Mfg. Co.
Finishing
Sheffield Corp., The
Flexible
Walker-Turner Co., Inc.

(*Turn to page* 108, *please*)

Responsibility

IN HIGH PLACES

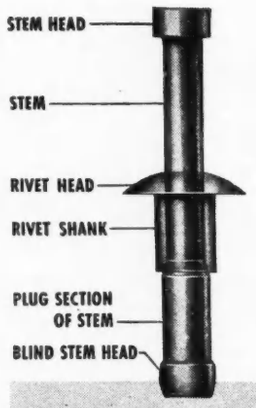
To Air Corps, AN and Navy Specifications

● It's the ability to take responsibility—the stamina to keep on taking it—that carries men up in the armed forces.

It's both the stamina and engineered quality of Dole Aircraft Valves and Fittings that win them responsible places in the mechanism of war planes, transports, trainers . . . little spots of color (coded) in the maze of fuel, air, oil, oxygen, and hydraulic lines . . . responsible spots where functional failure is unthinkable in its consequences—and very unlikely after our multiple inspections.

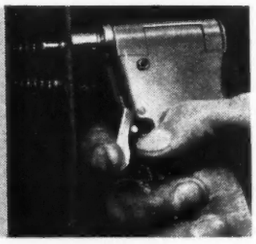
THE DOLE VALVE COMPANY
1901-1941 Carroll Avenue, Chicago, Illinois
LOS ANGELES • • DETROIT • • PHILADELPHIA

DOLE *Aircraft Valves and Fittings*



THE STEM DOES THE WORK IN A CHERRY BLIND RIVET

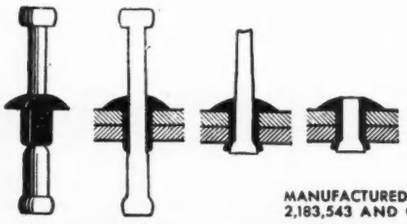
Positive head formation and shank expansion produced by rivet stem. No bucking bar needed



The Cherry Rivet is designed to do a first class riveting job in the blind or hard-to-get-at places in aircraft structures. This rivet is actually an assembly, consisting of a standard aircraft rivet which has been drilled and through which passes an aluminum alloy mandril or stem.

SPECIAL GUNS USED—The rivet can be placed in the work first or the projecting stem can be placed in the gun head and then inserted in the work. The gun may be either a hand-operated or power tool. (Head of the G-15 Pneumatic Gun is shown above.) In either case the gun pulls on the stem and pushes on the rivet head. As the stem is pulled through the rivet it forms a tulip head on the blind side, expands the shank of the rivet and permanently plugs the rivet. The pull continues until the stem breaks and frees the gun. The stem is trimmed flush with flat ground nippers.

FAST OPERATION—Cherry Rivets can be applied at the rate of 800 to 1600 per hour depending upon the type of rivet used. They give satisfactory performance with reasonable tolerances in grip length and hole size. Complete instruction on Cherry Rivets and their application will be furnished on request.



Mandril in the self-plugging Cherry Rivet, when pulled by special gun, forms a tulip head, expands rivet shank, permanently plugs the rivet and then breaks, releasing gun. The mandril is trimmed.

MANUFACTURED UNDER U. S. PATENT NO. 2,183,543 AND OTHER PATENTS PENDING

Cherry Rivet Company
LOS ANGELES, CALIFORNIA

BUYERS' GUIDE—(*Continued from page* 106)

Machines (Continued)

Gear Cutting, Hobbing & Lapping
Barber-Colman Co.
National Broach & Machine Co.
Norton Company

Grinding
(See Grinding Machines)

Honing (Cylinder)
Barnes Co., W. F., & John
Micromatic Hone Corp.
Sunnen Products Co.

Metal Working
Emerman & Co., Louis E.
Whitney Metal Tool Co.

Milling
(See Milling Machines)

Sanding
Heald Machine Co.

Straightening
Littell Machine Co., F. J.

Tapping
Rehnberg-Jacobson Mfg. Co.

Testing
Birdsboro Steel Foundry & Machine Co.
National Broach & Machine Co.

Turret, Automatic
Potter & Johnston Machine Co.

Washing, Metal Parts
Blakeslee & Co., G. S.
Detroit Rex Products Co.

Machining

Engine Parts (Aircraft)
Govro-Nelson Co.

Nuts

Boots Aircraft Nut Corp.
Palnut Co.
Progressive Mfg. Co., The
Republic Steel Corp.

Packing

Fitzgerald Mfg. Co., The

Leather
Chicago Rawhide Mfg. Co.

Pads

Felt
American Felt Co.
Felters Co., Inc.

Paint

Aluminum
Aluminum Co. of America

Pistons

Aluminum Co. of America
Sterling Aluminum Products, Inc.

Plastics

DuPont de Nemours & Co. (Inc.), E. I.
Rohm & Haas Co.
Thiokol Corp.

Plugs

Connector
Cannon Electric Development Co.

Drain (Magnetic)
Lisle Corp.

Presses

Drill
Walker-Turner Co., Inc.

Hydraulic & Forging
Birdsboro Steel Foundry & Machine Co.
Clearing Machine Corp.
Denison Engrg. Co.
Lake Erie Engrg. Co.
Watson-Stillman Co.

Stamping
Emerman & Co., Louis E.

Primers

Engine
Dole Valve Co.

Publishers

Business Publishers Intn'l. Corp.

(*Turn to page* 110, *please*)

Longer Service from Your CURTIS AIR HOISTS and CYLINDERS

Curtis Air Hoists and Curtis Air Cylinders are speeding production of war work, releasing skilled labor for other jobs, and reducing costs in plants all over America. Curtis Air Hoists can be operated by unskilled labor, are easily handled by women, and, because they cannot be overloaded, are practically immune to abuse.

But despite their simplicity of construction and operation, proper maintenance will help to insure and extend their unusually long life — for in many cases they may have to last for the duration.

Follow these maintenance tips, and you'll get the longest possible service from your Curtis air-powered equipment:

1. When running a new air supply line, or relocating an old one, be sure to blow out all grit, rust, and chips before connecting to the hoist.

2. Do not install hoists close to an open furnace or other source of heat without shielding, otherwise piston leather may char or lubricant dry out.

3. For smooth operation and long life, put one-half pint of heavy cylinder oil into the cylinder through the oil plug in rear head every 30 days. This keeps piston leather soft and prevents air leakage.

4. If piston jumps or jerks, it indicates improper oiling or binding of rod stuffing box. Keep stuffing box leak-tight only.

5. Fill oil cup on valve every 30 days. This admits two drops of oil every time hoist valve is operated.

6. Drain off any condensation in cylinder periodically through drain plug in lower head.

7. Check valve disc and seat occasionally to prevent wear from grit or dirt in air line. A worn valve causes "creeping" and loss of efficiency.

8. By keeping hoists and cylinders clean, properly lubricated, and by replacing broken or worn out parts now, you can increase the efficiency and long life of your equipment and prevent production shutdowns in the future.

CURTIS PNEUMATIC MACHINERY DIVISION
of Curtis Manufacturing Company
1917 Kienlen Avenue St. Louis, Missouri

Independent laboratory tests of Booth mechanical felt parts are surprising design engineers as to the ability of felt to serve *better* in scores of aircraft and machine applications.

Booth "prescription" felts are made to fit the task . . . with ingredients "compounded" to give the exact end properties desired in the precision-cut parts. It may pay you to know the properties and savings obtainable. Write for the Booth condensed textbook, "The Technique of Felt Making." The modern felt technology described, may be a revelation to you.

THE BOOTH FELT COMPANY
481 19th Street, Brooklyn, N. Y.
737 Sherman Street, Chicago, Illinois

ALSO . . . COMBINATION APPLICATION CHART AND SAMPLE FILE

. . . yours for the asking. Standard file size. Contains actual swatches of S.A.E. felt types, with complete specification tables. No obligation . . . no sales follow-up.

1909

TRADE MARK
Booth
Precision Cut Felt Parts

HAVE YOU A CRITICAL NON-FERROUS METAL PROBLEM?
TWO MONTHS AGO
JOHN—OUR PRODUCTION MUST BE INCREASED. WE MUST GET MORE METAL — AND I HAVE AN IDEA.
OK FELLA—BUT HOW ARE YOU GOING TO GET A LARGER ALLOCATION OF THE NON-FERROUS METALS WE'RE USING?
HERE'S ONE SOLUTION THAT IS SUCCESSFULLY MEETING REQUIREMENTS
- - TODAY
BILL — YOU HAVE DONE A SWELL JOB — OUR PRODUCTION IS UP SUBSTANTIALLY AND I'LL ADMIT I NEVER THOUGHT STEEL WOULD SERVE AS WELL AS OTHER METAL ON THIS JOB.
THIS IS A SPECIALTY STEEL—CMP PRECISION COLD ROLLED STRIP! THEY WORKED WITH US UNTIL THE ESSENTIAL MATERIAL CHARACTERISTICS WERE MET.

VERSATILITY — ANOTHER CMP PRECISION STRIP ADVANTAGE

How can you use CMP cold rolled strip steel to replace critical light gauge non-ferrous metals? Yes — that was the challenge. And for important war equipment parts it has been achieved with remarkable success.

By making a wide range of physical properties available to meet the essential service characteristics desired, CMP light gauge strip offers broad adaptability. CMP precision rolling for unusual close tolerances and the precise control of uniformity for consistent duplication provides a metal that assures trouble-free fabrication for low cost top production results. It's worth investigating now for your vital war production and good to have the facts for your postwar plans. Write today or phone Youngstown 4-3184 for immediate information.

CMP — PRECISION COLD ROLLED STRIP STEEL

LET'S ALL HELP TODAY

Get in the Scrap!

THE COLD METAL PRODUCTS CO.

Subsidiary of The Cold Metal Process Co., Youngstown, O.

BUYERS' GUIDE—(*Continued from page* 108)

Pulleys, Belt
Spun Steel Corp.

Pumps
Fluid Metering
Adel Precision Prod. Corp.
Machine Tool
Tuthill Pump Co.

Radio Accessories
Auto
Electro Products Laboratories

Reamers
Chucking
Barber-Colman Co.

Retainers
Grease
Victor Mfg. & Gasket Co.

Rings
Piston
McQuay-Norris Mfg. Co.
Muskegon Piston Ring Co.
Sealed Power Corp.

Rivets & Studs
Cherry Rivet Co.
Progressive Mfg. Co.
Republic Steel Corp.

Rods
Connecting & Welding
Aluminum Co. of America
Lincoln Electric Co.
Wilson Welder & Metals Co., Inc.

Rubber
Synthetic
Thiokol Corp.

Saws
Walker-Turner Co., Inc.

Screw Machine Products
Barnes Co., Wallace, Div. Associated Spring Corp.

Screw Stock
Cold Drawn & Shafting
Union Drawn Steel Div. Republic Steel Corp.

Screws
Machine
Progressive Mfg. Co.
Tapping & Threading
Shakeproof, Inc.

Seals
Grease & Oil
Chicago Rawhide Mfg. Co.
Fitzgerald Mfg. Co., The
Victor Mfg. & Gasket Co.

Shafting, Steel
Union Drawn Steel Div. Republic Steel Corp.
Cold Drawn
Union Drawn Steel Div. Republic Steel Corp.
Hollow
National Tube Co., U. S. Steel Corp. Subsidiary

Shafts
Flexible
White Dental Mfg. Co., S. S.
Propeller & Drive
Mechanics Universal Joint Div. Borg-Warner Corp.
White Dental Mfg. Co., S. S.

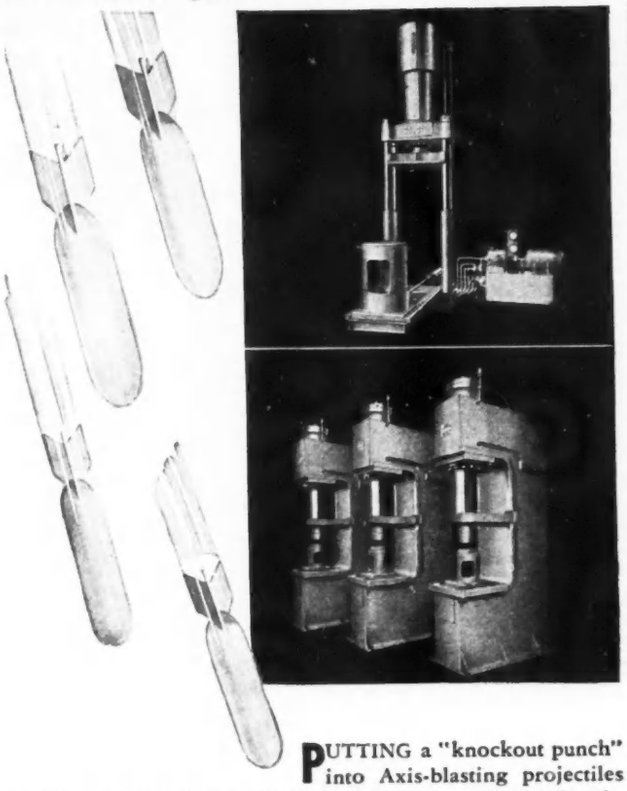
Shims
Leather
Chicago Rawhide Mfg. Co.

Solvents
Oil & Grease
Blakeslee & Co., G. S.
Detroit Rex Products Co.

(*Turn to page* 112, *please*)

Shell Loading
Bomb Loading

Two war jobs for W-S presses



PUTTING a "knockout punch" into Axis-blasting projectiles —loading high-explosive shells as well as armor-piercing bombs —these are the vital war duties of a group of presses built by Watson-Stillman.

At this time we cannot say how many there are, or where they are. But it's no military secret that production schedules for these presses will exceed the specification speeds.

This ammunition-serving equipment takes its place beside many other Watson-Stillman hydraulic presses which are packing a war wallop—those which are straightening gun barrels—those which are bending the keels of tomorrow's transports—those which are producing aircraft parts, powder, and shell forging.

Elsewhere throughout the wartime metal industries, you will find scores of other W-S units—many kinds of presses, high-pressure pumps, jacks, fittings and valves for hydraulic service. Write for General Bulletin 110A. The Watson-Stillman Company, Roselle, New Jersey.

In fact, wherever jobs can be done hydraulically Watson-Stillman serves you

WATSON-STILLMAN

Engineers and Manufacturers of Hydraulic Machinery and Equipment— Hydraulic Presses, Pumps and Jacks, Forged Steel Valves and Fittings

GETTING A START WITH CANNON PLUGS

The ground battery for aircraft which supplies auxiliary current for starting engines or testing radio and control devices is often connected to the plane through this Cannon Connector. By this means the batteries on the plane are relieved of the extra load of starting cold motors and their charge may be saved for the necessary functions while in flight.

A small third terminal shown in these fittings is used to operate a signaling device so that the pilot may know when the ground battery has been disconnected.

This is only one of thousands of specialized electrical connectors built by Cannon. All are precision built and embody many features that aid the men who use them. They are all backed by a quarter century of experience in the electrical specialty business.

CANNON SERVES MANY INDUSTRIES

The aircraft industry is only one user of Cannon Connectors. They are standard equipment in radio, television, sound studios and theatres. They are used in geophysical reseach, railroad rolling stock and in countless fields where dependable connections are needed.

Pony Express Battery Cart, manufactured by Rocky Mountain Steel Products Company, Los Angeles, features 12 and 24 volt service handled through 2 sets of cables. Large plugs with 4 contacts are special Cannon Type M-1 Connectors.

CANNON ELECTRIC

CANNON ELECTRIC

Cannon Electric Development Co., Los Angeles, Calif.

Canadian Factory and Engineering Office:
Cannon Electric Company, Limited, Toronto, Canada

a complete line of *Permanently Accurate*

Torque Wrenches

STURTEVANT

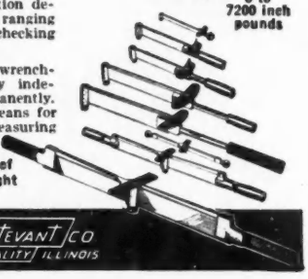
NO FRICTION ADJUSTMENTS MOVING PARTS FRAGILE MECHANISMS

SIZES Capacities from 0 to 7200 inch pounds

Torque Wrenches are used in leading industrial, automotive and aircraft plants to control the set of screws and nuts in production departments . . . to measure and test applied torque or resistance in laboratories and inspection departments — and for innumerable jobs ranging from building delicate instruments to checking frictional drag in giant diesel motors.

Built by the pioneer in accurate gauging wrenches, they are more accurate, practically indestructible they retain this accuracy permanently. They have brought to industry a new means for product control and for gauging and measuring torque in its thousands of applications.

Write for Bulletin describing use of STURTEVANT Wrenches at Wright Aeronautical Co.



PA STURTEVANT CO
ADDISON QUALITY ILLINOIS

QUIET, PLEASE

Noisy, nerve-wracking machines reduce workers' efficiency. Amfelt isolators absorb vibration, minimize noise. Low cost, easy to install. Write for Data Sheet #10.

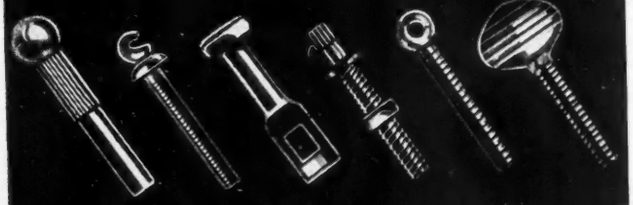
American Felt Company
TRADE MARK

New York Chicago Philadelphia Boston

General Offices: Glenville, Conn.

Cleveland Detroit St. Louis San Francisco

SPECIALS OUR REGULAR BUSINESS IS SPECIAL FASTENINGS — 25,000,000 A WEEK



The PROGRESSIVE MFG. CO.
TORRINGTON · · · CONNECTICUT

PJ . . for over 40 years THE PIONEER MANUFACTURER OF AUTOMATIC CHUCKING EQUIPMENT

POTTER & JOHNSTON MACHINE CO.
PAWTUCKET, RHODE ISLAND

BUYERS' GUIDE— (*Continued from page* 110)

Springs

Extension, Compression, Torsion or Flat

Barnes Co., Wallace, Div of Associated Spring Corp.
Barnes - Gibson - Raymond Div. of Associated Spring Corp.
Cook Plant of Barnes-Gibson - Raymond, Div. of Associated Spring Corp.
Gibson Co., Wm. D., Div. of Associated Spring Corp.
Muehlhausen Spring Corp.
Raymond Mfg. Co., Div. of Associated Spring Corp.

Stampings or Drawings

Metal

Barnes Co., Wallace, Div. of Associated Spring Corp.
Barnes - Gibson - Raymond Div. of Associated Spring Corp.
Cook Plant of Barnes-Gibson - Raymond, Div. of Associated Spring Corp
Gibson Co., Wm. D., Div. of Associated Spring Corp.
Niles Steel Products Div. Republic Steel Corp.
Raymond Mfg. Co., Div. of Associated Spring Corp
United Air Cleaner Div., United Specialties Co.
Worcester Stamped Metal Co.

Steel

Alloys

Allegheny Ludlum Steel Corp.
Carnegie - Illinois Steel Corp., U. S. Steel Corp. Subsidiary
Republic Steel Corp.
Union Drawn Steel Div. Republic Steel Corp.
Vanadium-Alloys Steel Co.

Bars

Bethlehem Steel Co.
Carnegie - Illinois Steel Corp., U. S. Steel Corp. Subsidiary
Columbia Steel Co., U. S. Steel Corp. Subsidiary
Republic Steel Corp.
Tennessee Coal, Iron & Railroad Co., U. S. Steel Corp. Subsidiary

Billets

Carnegie - Illinois Steel Corp., U. S. Steel Corp. Subsidiary
Columbia Steel Co., U. S. Steel Corp. Subsidiary
Republic Steel Corp.
Tennessee Coal, Iron & Railroad Co., U. S. Steel Corp. Subsidiary

Carbon

Carnegie - Illinois Steel Corp., U. S. Steel Corp. Subsidiary
Columbia Steel Co., U. S. Steel Corp. Subsidiary
Republic Steel Corp.
Tennessee Coal, Iron & Railroad Co., U. S. Steel Corp. Subsidiary
Vanadium-Alloys Steel Co.

Cold Drawn

American Steel & Wire Co., U. S. Steel Corp. Subsidiary
Union Drawn Steel Div. Republic Steel Corp.
Vanadium-Alloys Steel Co.

Cold Drawn Flats

Union Drawn Steel Div. Republic Steel Corp.

Cold Rolled Strip

Bethlehem Steel Co.
Cold Metal Products Co.
Thomas Steel Co.

BUYERS' GUIDE —*continued*

Electric Furnace

Carnegie - Illinois Steel Corp., U. S. Steel Corp. Subsidiary

Republic Steel Corp.

Vanadium-Alloys Steel Co.

High Speed Cutting & Nickel

Bethlehem Steel Co.

Plate

Republic Steel Corp.

Shapes

Carnegie - Illinois Steel Corp., U. S. Steel Corp. Subsidiary

Columbia Steel Co., U. S. Steel Corp. Subsidiary

Tennessee Coal, Iron & Railroad Co., U. S. Steel Corp. Subsidiary

Sheets

Bethlehem Steel Co.

Carnegie - Illinois Steel Corp., U. S. Steel Corp. Subsidiary

Columbia Steel Co., U. S. Steel Corp. Subsidiary

Republic Steel Corp.

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Carnegie - Illinois Steel Corp., U. S. Steel Corp. Subsidiary

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(*Turn to page* 114, *please*)

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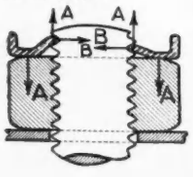

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(*Turn to page* 117, *please*)

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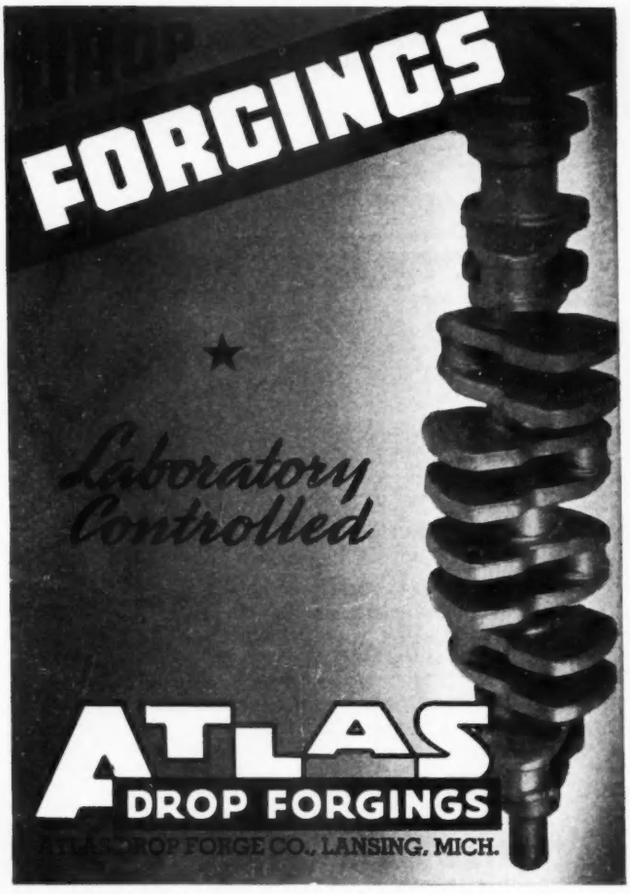

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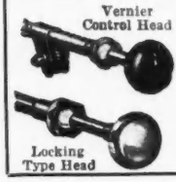

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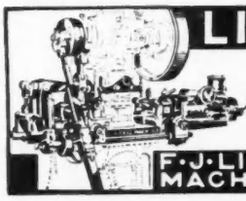

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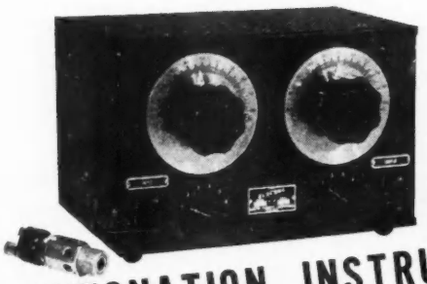

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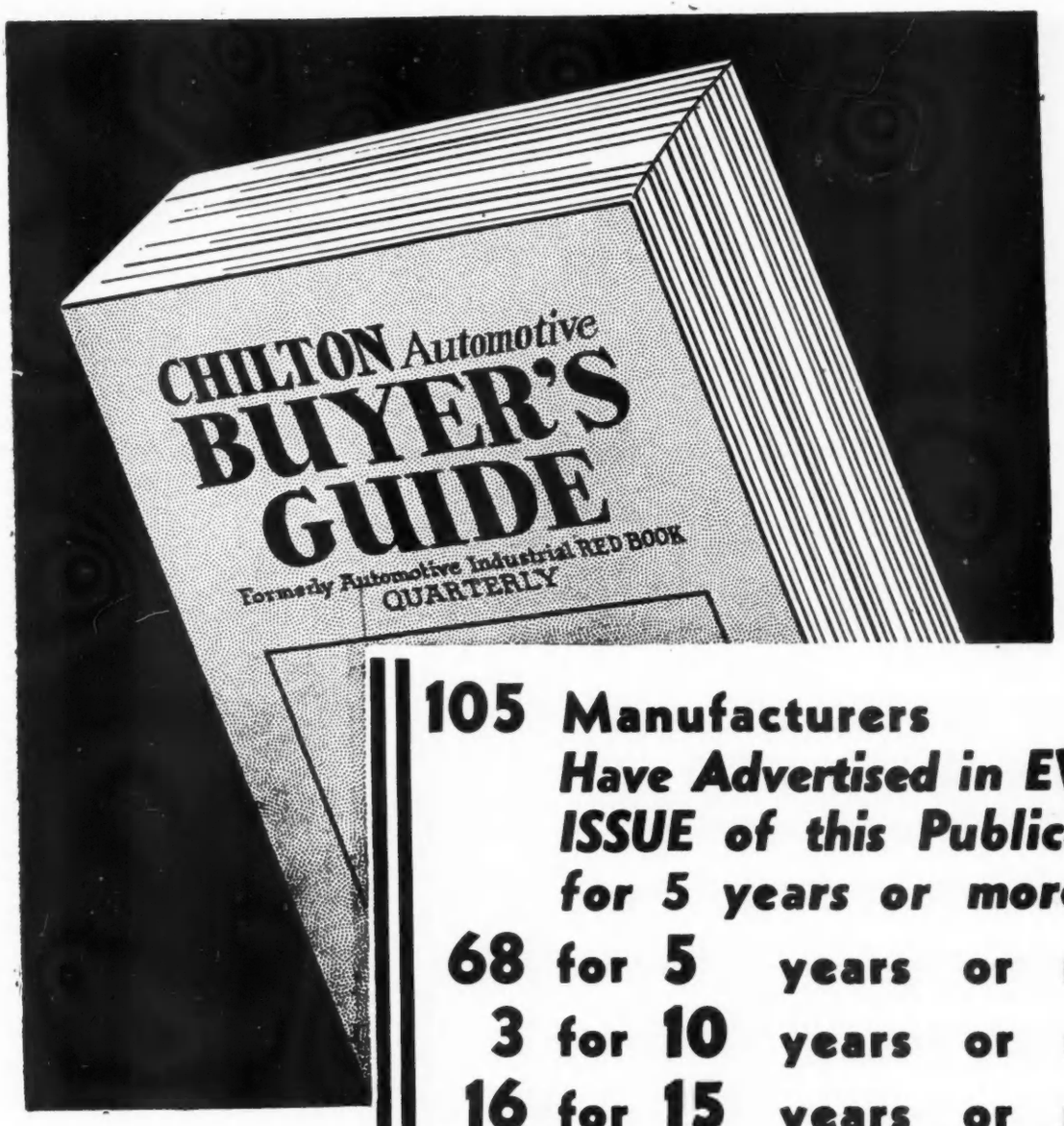

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V

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INTERNAL TYPE

COUNTERSUNK

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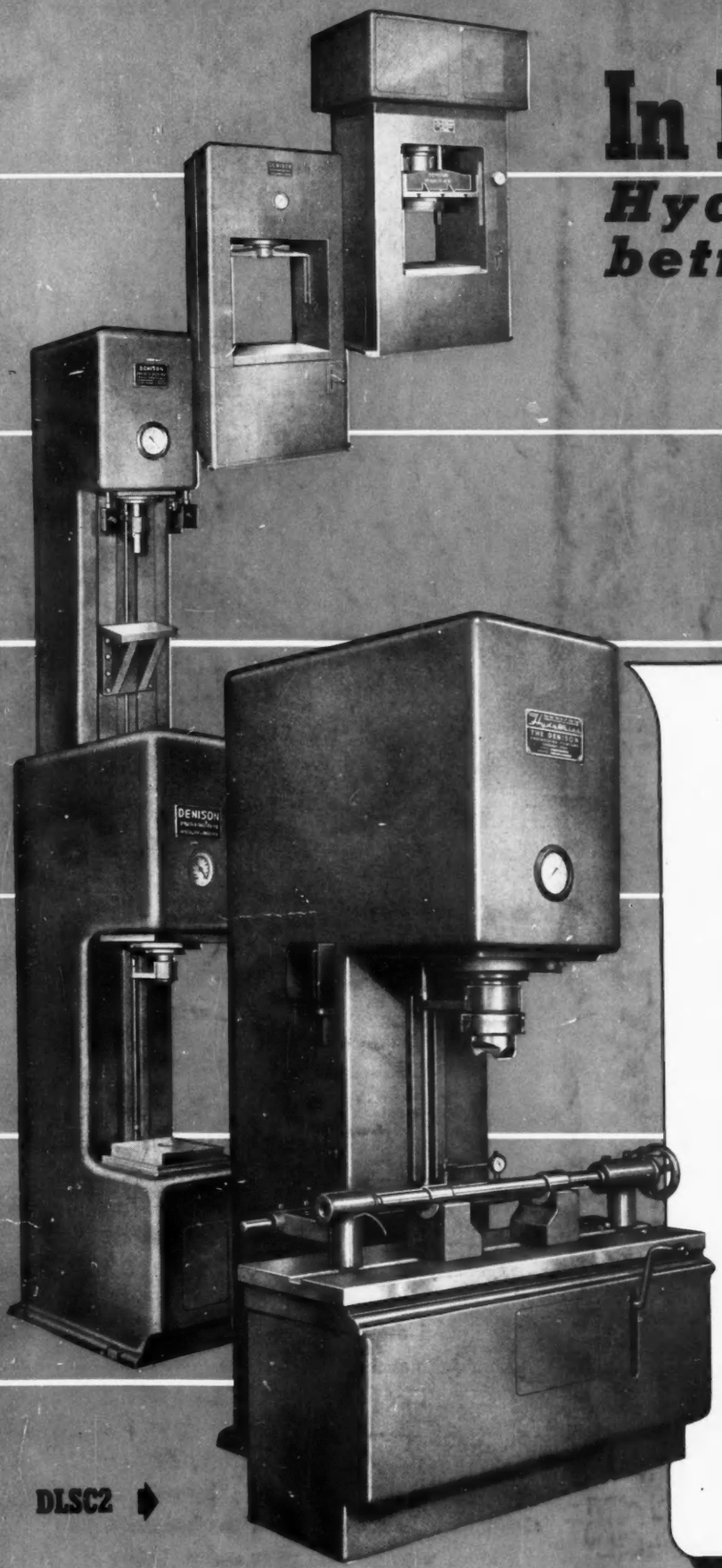

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